

Adjustable Ground Clearance in Vehicles Using Pneumatic Lifting

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Abstract- The handling of vehicle depends upon the various parameters; centre of gravity of the vehicle is one of them. For better handling of the vehicle we need to keep centre of gravity as low as possible. For sport cars it is always kept low but for the passenger cars it compromises with its ground clearance. The designers prefer to maintain fixed ground clearance and design the system to acquire requisite suspension parameters. For different type of tracks, the ground clearance of vehicle is designed accordingly and that is why this is a subtle reason which also differentiates the vehicles as on-road (Sedan/Hatchback cars) and off-road (Sports utility vehicles (SUV)). 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.

INTRODUCTION

Road conditions are not similar at all places; it changes with application, environment and climate. In city at different sectors like school, hospitals there are speed breakers of different dimensions. At certain condition road goes straight without any pits else we found irregularity. Most of the people buy only one four wheeler which they use that at all this condition. Hence it's necessary to give some standard ground clearance to the vehicle. But still there are some obstructions while driving the car on highway and in city. It is not possible for the off-road vehicle to run

at high speed on its standard ground clearance provided considering the city obstacles and on-road cars to run over the rough terrain with its lower ground clearance. To obtain the good performance at high speed and low speed it is necessary to build one system which can vary the ground clearance. This can achieve by changing the suspension height so that the chassis height can be adjusted with respect to the speed and the quality of roads. Suspension systems plays vital role while designing the car for good stability and road holding ability. It is very difficult to achieve this ability at all road condition with passive suspension system only. This problem can be solved by active suspension system but this is not widely used because it required more external energy and additional controlling system which affects the cost of the vehicle. With a view to reduce the complexity and the cost while improving ride, handling and performance we can use the combination of active and passive suspension system. In this paper various parameters are discussed which are related to the ground clearance and suspension system and its control. This gives the idea about the vehicle characteristics like ride control, height control, roll control, road holding etc. and its effect on vehicle performance. Ground clearance is the position of the vehicle body (sprung mass) above the basic ground level. It is an important parameter in off-road vehicle. For a certain car's weight, there is a certain amount of mechanical down force which act on tires, and therefore the grip of tires is constantly changing during running condition.

OBJECTIVES

- To further increasing the ground clearance by using pneumatic cylinder.

- To provide automation by IR sensor to detect the speed breakers and also rough terrains with certain distance

Need for Automation

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, pneumatics form an attractive medium for low cost automation. The main advantages of all pneumatic systems are economy and simplicity. Automation plays an important role in mass production.

Nowadays almost all the manufacturing process is being atomized in order to deliver the products at a faster rate. The manufacturing operation is being atomized for the following reasons.

COMPONENTS USED

1. Pneumatic Cylinder -

Here, the Double acting cylinder is used because air is admitted on both sides of piston. Hence, this cylinder or actuator can perform useful work in both directions. There is no spring in these actuators.



2. Pneumatic Hose:

A hose is a flexible hollow tube designed to carry fluids from one location to another. Hoses are also sometimes called pipes (the word pipe usually refers to a rigid tube, whereas a hose is usually a flexible one), or more generally tubing. The shape of a hose is usually cylindrical (having a circular cross section).

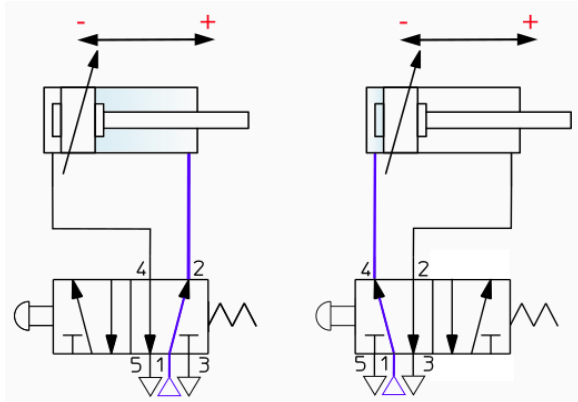
3. Hoses & Connectors

Hoses used in this pneumatic system are made up of polyurethane. These hose can with stand at a maximum pressure level of $10 \times [10]^5 \text{N/m}^2$. 2.5 Non-Return Valve a check valve, clack valve, non-return valve or one-way valve is a mechanical device, a valve, which normally allows fluid (liquid or gas) to flow through it in only one direction. Check valves are two-port valves, meaning they have two openings

in the body, one for fluid to enter and the other for fluid to leave.

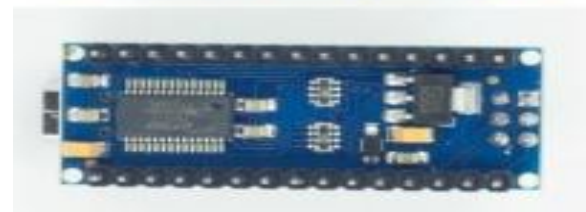
4. Solenoid Valve

5/2-way valves are used to actuate double acting pneumatic actuators, such as cylinders, rodless cylinders, grippers and rotary actuators. Double acting actuators require compressed air to move in both directions. To decide whether a mono-stable or bi-stable 5/2-way valve should be applied, it is necessary to know more about the system's design and requirements.



5. Arduino

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x) or ATmega168 (Arduino Nano 2.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package.



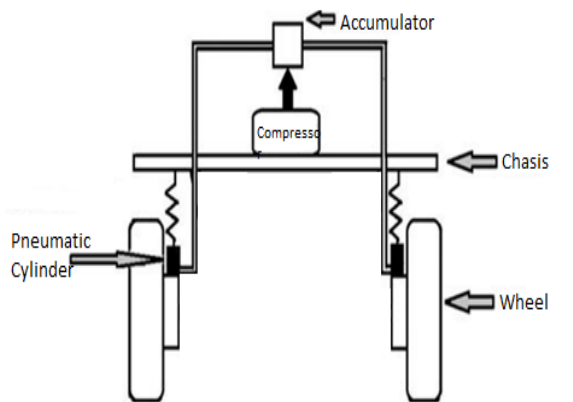
6. Arduino Nano Expansion Shield

Arduino Nano IO Expansion Shield is specifically designed to facilitate an easy connection between Arduino Nano and many other devices. In essence, it expands the Arduino Nano controller to link those devices in a simple and trouble free manner.

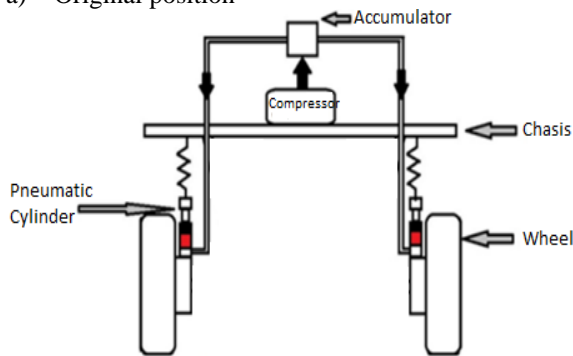


PROPOSED METHOD

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.



a) Original position



b) Position after pneumatic lifting

The whole lifting mechanism act as active suspension system consisting of four pneumatic cylinders which are mounted between each wheel assembly and passive suspension system in such a way so that the

outer dead centre of cylinder faces upwards and inner dead centre faces downwards. The inlet of each cylinder is connected to the accumulator via air tubes. Accumulator is attached to the outlet of reciprocating compressor through air tubes which is mounted over the chassis at the fixed position. An electric motor drives the reciprocating compressor using the battery power which is charged by the engine. There are two button system 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.



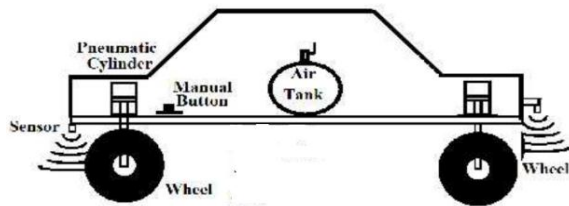
(a)



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.

WORKING

The IR sensors detect the obstacles (speed breakers, slopes etc.) and sends signals to the ECU circuit. Pneumatic lift in a vehicle can be achieved by pneumatic cylinder employing a reciprocating compressor and this can be done by receiving the signal from ECU circuit. 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. In order to affect mechanical motion, pneumatics employs compression of gases, based on the working principles of fluid dynamics in the concept of pressure.



CONCLUSIONS

Pneumatics actuators can act efficiently. The air required for the operating of the actuators is easily available in the nature. Cost of the project is not high compared with other systems as compared with hydraulic. As our actuators are inbuilt the fatigue is less. If made in the lot the cost could be less. It serves better than hydraulic.

The benefit behind this project results in avoiding the obstacle which can directly impact to chassis from below. Due to automatic adjustment, it is help for preventing the vehicle in off-road conditions.

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