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Design and Development of Autonomous Speed and Ground Clearance Adaptation System

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Abstract:- This paper presents design and development of autonomous speed and ground clearance adaptation system. The handling of a vehicle relies on the different limits, the focus of gravity of the vehicle is one of them. We must keep the centre of gravity as low as possible for better handling of the vehicle. It is always kept low for sports cars, but it compromises with its ground clearance for the passenger cars, for different types of tracks, vehicle ground demarcation is well designed and that's why this is a tenuous reason why we classify cars as on-road and off-road. Off-road vehicles must deal with rugged terrain, where we need a high-speed car, on the other hand, we drive the same vehicle on a road where high ground clearance is not required. A sedan or hatchback, on the other hand, must travel on smooth roads as well as rugged terrains, with its set lower ground clearance, which might cause dents in the car's bottom. Our goal is to provide high ground clearance on rough roads, speed breakers and to reduce the same in order to obtain the necessary clearance to maintain high speed stability on smooth roads.

I. INTRODUCTION

Road conditions are not the same everywhere; they change with application, environment and climate. Speed breakers are installed in different sectors of the city, such as schools and hospitals. In certain conditions, roads run straight without any pot holes, otherwise we encounter irregularities. Many people buy only one vehicle, which they use in every condition. Therefore, it is necessary to provide a definitive height to the vehicle. However, there are obstacles while driving on highways and in cities. Due to these obstacles and ability to run on rough terrain, the off-road vehicles can't achieve greater speeds with the given clearance. To acquire the most efficiency at greater and lower speeds it is necessary to build a mechanism that can change the ground clearance of the vehicle. Achieving this by altering the spring and damper so that the frame height can be altered for the pace on various road conditions. Suspensions plays a crucial role in design the vehicle for enhanced resilience and road gripping capability. It is challenging to achieve this in every road condition with only one passive suspension system. This problem can be solved by an 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. We can use the combination of active and passive suspension systems in order to reduce complexity and cost while improving ride, performance, and handling. Various parameters relating to ground clearance, suspension, and its control are discussed in this project. These characteristics include ride command, height management, roll control and road holding capabilities and their effect on vehicle performance. Ground clearance refers to the height of the automotive above the ground. It is an imperative parameter in off-road automobiles. The whole weight of the vehicle is focused on the Centre of gravity. At the lower ground clearance, we get the center of gravity near the lower level. This eases the transfer of mass during cornering, accelerating and braking and hence, increases the performance and efficiency. Additionally, we can improve high-speed stability by declining the front and lifting the rear ends. To adjust ground clearance, we have developed an uncomplicated pneumatic linkage mechanism. A passive and an active suspension are linked together in series to allow for adjustment. On top of the passive suspension is the active suspension. With the help of this system, we can vary the height of the automobile up to 100 mm. The power from compressed air is used to create a pressure that is applied in a reciprocating linear motion by pneumatic cylinders. Hydraulic cylinders work by having a force on the piston to move in a certain direction. As a result, a lift is produced. When necessary, compressed air is utilized to produce a lift to improve the ground clearance, otherwise, it lowers the chassis to have normal ground clearance by acting as an active suspension system.

II. PROBLEM STATEMENT

The treatment of vehicle relies on the different boundaries, focus of gravity of the vehicle is one of them. For better treatment of the vehicle, we must keep focus of gravity as low as could really be possible. The ground clearance of sport vehicles is kept low, however for passenger vehicles it is compromised. As far as the suspension parameters are concerned, designers prefer to maintain fixed ground clearance. Different types of tracks require different ground clearances, so this is a subtle factor that distinguishes between on-road (sedans and hatchbacks) and off-road (sport utility vehicles (SUV)). On the other hand, off-road vehicles must cope with harsh landscape, where they need high ground clearance, and on a road, the same vehicle does not require a high ground clearance. With the fixed lower ground clearance of a

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sedan or hatchback, they to run on smooth streets as well as harsh landscapes at times, which can result in dents on the lower part of the vehicle. In these cases, a vehicle's ground clearance system needs to be able to adjust in order to operate optimally. Specifically, this paper introduces a pneumatic lifting technique that provides the higher ground clearance on rough roads/breakers and lower ground clearance on smooth roads to keep vehicle stability at high speeds.

III. OBJECTIVE

- For ground clearance system pneumatic cylinders are used which will adjust the height of purchases according to the road condition if the driver is driving the car on off road so the chassis tend to touch the ground when the surface is not uniform so at that time by pressing a single button the operator can height adjust the height of chassis according to his customers requirement.
- To reduce the speed of car or to stop the car by detecting the speed breaker or by detecting another car in front of sensor.
- To design and develop the system by using low-cost Arduino circuit and develop the IR sensor-based sensing system.

IV. PROPOSED MODEL

A. System Overview

In this project design and development of autonomous speed and ground clearance adoption system is done. Here we are manufacturing a small prototype model and its chassis is made of square tube for good rigidity. The system is provided with four wheels which will be rotated by using PMDC gear motor. battery is mounted on the frame of Chassis. The four wheels is mounted on the 20mm shaft which is mounted on chassis with the help of pedestal bearing. The power is transmitted from PMDC gear motor to shaft with the help of gear and chain mechanism. The whole assembly is mounted on angle frame and disconnected to chassis with the help of pneumatic cylinder. The pneumatic cylinder will act as ground clearance adoption system in this project. In the front portion of chassis IR sensor is mounted. IR sensor senses the obstacle in front of vehicle and give the signal to Arduino circuit for reducing the vehicle speed or to stop the vehicle Pneumatic cylinder mounted on chassis is having 100 mm stroke length which will be used for maintaining the required size of ground clearance. The Arduino microcontroller is used as a circuit for receiving the signal from IR sensor and to give output signal to motor and solenoid valves.

B. SYSTEM DESIGN

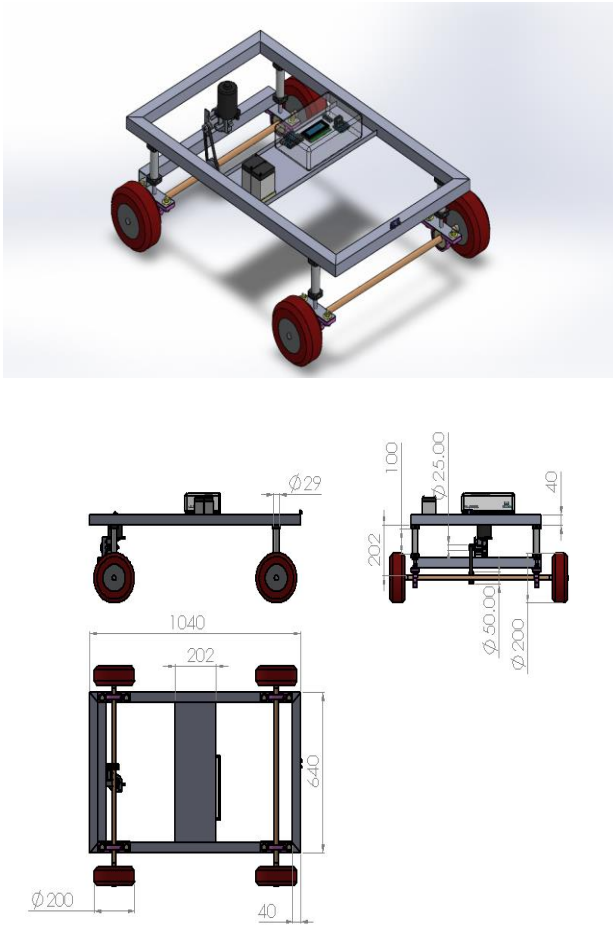

Fig. 1: Drafting and Model

The requirement of hardware and software for designing of system is as follows: -

1.	Pneumatic cylinders
2.	Compressor
3.	IR sensors
4.	PMDC Motor
5.	Steel frame (chassis)
6.	Battery (12v)
7.	5/2 DCV SOLENOID
8.	Relay Board

Table 1

V. CALCULATIONS

Material = C 45, mild steel

Why Mild Steel C-45 is selected in our project.

Easily available in all sections.
Welding ability
Machinability
Cutting-ability
Cheapest in all other metals.
Take fos+2

$\sigma_t = \sigma_b = 540/fos$

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= 270 N/mm^2

$\sigma_s = 0.5\ \sigma_t$

= 0.5 x 270

= 135 N/mm^2

A. Design of motor:

Power of Shaft = P = 15 watt

Power transmitted,

$$P = \frac{2\pi NT}{60}$$

Where, N- Rpm of motor shaft = 18

T- Torque transmitted

$$15 = \frac{2\pi \times 18 \times T}{60} \times 10^3$$

T = 7.95 x 10^3 N-mm

B. Design of shaft

Now, T1 is the maximum torque among all shafts, therefore we will check shaft for failure here.

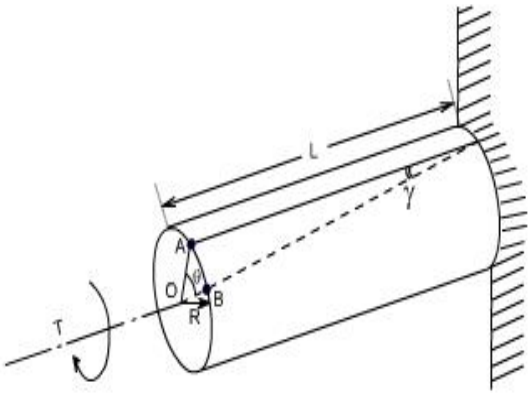

Fig. 2: Shaft design

$$T = \frac{\pi\, \sigma s\, d^3}{16}$$

$7956.7 = \pi /16 \times 135 \times d^3$

D= 6.69 mm.

But we are using 20 mm shaft, so our design is safe.

C. Selection of bearing

For 20mm Shaft diameter we take standard breaking no. P204

Fig. 3: P-204 bearing

P=pedestal bearing

2=spherical ball or deep groove ball bearing

=04 =5 × 4 = 20mm

Bore diameter of bearing,

D. Calculate the size of cylinder:

Area x Pressure = Force Output

The compressor will give maximum 9 bar pressure = 0.9 N/mm^2

Area = $\pi\ r^2$

Area = 3.142 x 12.5^2

Area = 490.87 mm^2

Force = 441.78 N = 45 kg

STANDARD STROKE

DOUBLE ACTING (D)

BORE (mm)	STANDARD STROKE (mm)	MAX. STROKE (mm)
8	25, 50, 75,100	100
12	25, 50, 75,100	100
16	25, 50, 75,100	200
20	25, 50, 75,100, 150, 200	1000
25	25, 50, 75,100, 150, 200, 250, 300	2000

Fig. 4: Bore Stroke Chart

Stroke length required for maintaining ground clearance height adjustment is 100 mm So we will select cylinder of 25 mm diameter and 100 mm stroke length.

VI. CONCLUSION

This system essential in current scenarios where the roads are heavily flowing with mixed traffic keeping a safe distance between two vehicles. It is useful for off-road vehicles for better obstacle prevention and comfort of

passengers. Moreover, the system will avoid accidents by detecting objects in front and come to a complete rest if required to ensure the safety of passengers, pedestrians and other vehicles. This will also result in increased economy of the vehicle.

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