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Automatic Ground Clearance Adjusting Vehicle

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Abstract: *The handling of vehicle is very challenging towards the off-road. Suspension is on of the most challenging system to design for the off-road vehicle. The proper suspension design should be adaptive to changing road condition. Hence designer adopt to maintain fixed ground clearance and design the system to require satisfactory parameter. off-road vehicle have to face the rough patches on road where the customer need the high ground clearance of the vehicle, on other sides in cities we run the same vehicle on road where high level ground clearance is not needed. So for different type of tracks, the vehicle ground clearance is designed accordingly and this differentiate the vehicle for On road vehicle (sedan & hatchback cars) and for off-road vehicle there are suitable SUV. In both the cars we needed an adjustable ground clearance system in the vehicle to have finest performance.*

Keywords: Ground clearance, SUV, Off-Road

I. INTRODUCTION

Ground clearance is the position of the vehicle body (sprung mass) above the basic ground level. It's an important parameter in off-road vehicle. For a certain car's weight, there is a certain amount of mechanical down force act on tires, and therefore the grip of tires is constantly changing during running condition. The whole weight of vehicle is concentrated at a point known as a center of gravity point. Ground clearance is a critical factor in several important characteristics of a vehicle. For all vehicles, especially cars, variations in clearance represent a trade-off between handling and practicality.

Road conditions are not similar at all places; it changes with application, environment and climate. In city at different sectors like school, hospital there is 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 is some obstruction 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. We will design a pneumatic mechanism for ground clearance adjustment. The adjustment is possible at bump conditions with the help of pneumatics. With the help of this system we can vary ground clearance

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of the vehicle. The system consist a new fabricated shock absorber structure. We can adjust the ground clearance of our vehicle in different stages with different ground clearance by using obstacle sensor.

II. LITERATURE SURVEY

Hrishikesh V Deo & Nam P Suh[4] introduced that how the comfort and handling are interrelated with CG 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. To controlling the height and stiffness 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 comes 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[5] 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. To give the information about vital role of ground clearance Debojyoti Mitra 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 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.

Guangqiang Wu, Guodong Fan, and Jianbo Guo presented ride comfort evaluation for road vehicle based on rigid-flexible coupling multibody dynamics. Spectrum of vibrations occurs in the vehicle due to various speeds. There are different road profiles and roughness therefore occupants are subjected to accelerations in different directions, which caused discomfort. With the help of ADAMS-CAR they built rigid and rigid flexible coupling multi-body vehicle models. As speed increases the relative difference goes increases, at 80 km/hr it becomes 8%. It is better to build the variable suspension with rigid flexible coupling.

Mohammad, Mahir and Iyad gives new control strategy for active suspension using modified fuzzy and PID controllers. In this they proposed controlled strategy to control the suspension system by means of electro-hydraulic actuator. The passive suspension is replaced by low frequency active suspension. The quarter car model tested under rolling effect, cornering and pitching effect at different speeds and road profiles. The reduction in body acceleration by 60% gives better road holding and car stability. There are two types of active suspensions which are commonly recognized that are low bandwidth and high bandwidth. Non-linear controllers are more capable to handle high bandwidth active suspension because they show good capability at worst road condition. Researchers gives the linear controller over active suspension of low bandwidth new PID with fuzzy switch which improve the performance of suspension.

The design of suspension is concern with three main parameter; car body acceleration for ride comfort, the tire deflection for road holding and the suspension travel. The ideal suspension system would minimize these three quantities for any road and operating condition, which is not achievable for suspension having constant spring stiffness and damping. This can be achieved by active suspension system. But this needed high external energy. Hence it is not

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widely used. The alternative solution is to use of semi-active suspension. It reduces car body resonance without compromising road holding. But this solution gives disturbance like jerk, rattling noise etc. Hence C. Collette, A. Preumont presented paper on energy transfer in semi-active suspension that the energy transfer phenomenon may be bearable up to certain extent by filtering the control signal or providing suitable mounting.

III. COMPONENT

3.1 Ultrasonic Sensor

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect from boundaries to produce distinct echo patterns. Ultrasonic sensing is one of the best ways to sense proximity and detect levels with high reliability. Ultrasonic sound vibrates at a frequency above the range of human hearing. Transducers are the microphones used to receive and send the ultrasonic sound. Ultrasonic sensors, like many others, use as single transducer to send a pulse and to receive the echo. The sensor determines the distance to a target by measuring time lapses between the sending and receiving of the ultrasonic pulse. The working principle of this module is simple. It sends an ultrasonic pulse out at 40kHz which travels through the air and if there is an obstacle or object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated

3.2 Pneumatic Cylinder

Pneumatic cylinder is mechanical device which use the power of compressed gas to produce a force in a reciprocating linear motion. Like hydraulic cylinder, something forces a piston to move in the desired direction. The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved. Engineers sometimes prefer to use pneumatics because they are quieter, cleaner, and do not require large amounts of space for fluid storage. Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatics more desirable where cleanliness is a requirement. For example, in the mechanical puppets of the Disney Tiki Room pneumatics are used to prevent fluid from dripping onto people below the puppets.

3.3 Motor

A motor is an electrical machine that converts electrical energy into mechani*cal energy Most electric motors* operate through the int*eraction between the motor's* magnetic field and electric current in a wire winding to generate force in the form of rotation of a shaft. Electric motors can be powered by direct current (DC) sources, such as from batteries, motor vehicles or rectifiers, or by alternating current (AC) sources, such as a power grid, inverters or electrical generators. An electric generator is mechanically identical to an electric motor, but operates in the reverse direction, converting mechanical energy into electrical energy. Electric motors may be classified by considerations such as power source type, in*ternal construction, application* and type of motion output. In addition to AC versus DC types, motors may be brushed or brushless may be of various phase (see single-phase two-phase or three-phase), and may be either air-cooled or liquid-cooled. General purpose motors with standard dimensions and characteristics provide convenient mechanical power for industrial use. The largest electric motors are used for ship propulsion, pipeline compression and pumped-storage applications with ratings reaching 100 megawatts. Electric motors are found in industrial fans, blowers and pumps, machine tools, household appliances, power tools and disk drives. Small motors may be found in electric watches.

IV. DESIGN SPECIFICATION

Double acting pneumatic cylinder
Given date:
Cylinder: 20*150
Bore diameter= 20mm
Stroke length= 150mm

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Volume of air exhaust =stroke *area of piston
=150*π/4*
=47123.889mm^3
Area of piston =π/4*20^2=314.15mm^2
Outstroke force (F) = pressure *Area of cylinder
=0.6*314.15
=188.49 N
Piston rod area = π/4*d^2
= π/4*7^2
=38.48mm^2
Effective area= piston area- piston rod area
=314.15-38.48
=275.66 mm^2
The force applied to lift the crane in this problem is the instroke force.
In-stroke force for various pressures,
1 .P =0.4Mpa
2. In-stroke force= P*A
= 0.4*275.66
= 110.264N
P =0.6MPa
In-stroke force= P*A
4. =0.6*275.66
=165.39N
3. P =0.85MPa
In-stroke force= P*A
= 0.85*275.66
= 234.311N
We have considered frame size as,
Length of frame=762 mm
Breadth of frame=610 mm
Now in our design as on the length part of the frame overall weight of the system is placed so the length part is considered as beam, and design is done accordingly
While designing the beam is considered as overhang beam as two motors are placed between the ends of beam, with uniformly distributed loading,
Hence
UDL=100 N/m
Considering total mass of the prototype as 10kg.
Now to calculate reactions we need to simplify the load diagram. Considering equilibrium conditions,
Now to find the reactions at A and B,
1. Moment about A is considered as 0. So, Rb=37.54 N
2. Forces in Y direction=0. So, Ra=38.56 N
Now we are doing calculations for shear force diagram.
SFcl=0 SFcr=0
SFal=-15.2 N SFar=23.36 N
SFbl=-22.34 N SFbr=15.2 N
SFdl=0 Sfdr=0
Now we are doing calculations for bending moment diagram,
BMc=0

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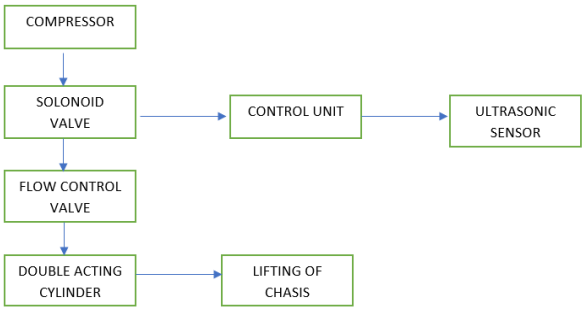
BMa=-1.15 N-m
BMb=0.23 N-m
Bmd=0
Now we know that a point at which shear force is zero maximum bending moment occurs. X is the point at which maximum bending moment occurs.
BMx=4.30 N-m=0.0043 N-mm
Now we are using the square cross sectional pipe with thickness as 2 mm.
So according to flexure formula for bending stress,

(M/I)=(σ/Y)

Now we know that,
M=0.0043 N-mm
Y=18.85 mm---------(distance of neutral axis)
By using the parallel axes theorem we can calculate the moment of inertia (I)
I=IXX1-IXX2
I=(616.03-529.40)*10^3 =86.62*10^3 mm4
So from above data we can calculate,
(0.004)/(86.62*10^3)=(σ/18.85)
Hence σ =0.858 N/m2
This is the maximum permissible stress acting on frame.

V. BLOCK DIAGRAM



VI. CONCLUSION

1. We have concluded that this project model can be heavily commercialized in various industries.
2. This innovation can help driver to choose the ground clearance with his comfort of driving.
3. We can conclude that this type of mechanism is very essential in current scenarios where the roads are heavily flowing with mixed traffic keeping safe distance between two vehicles.
4. The benefit about this project results in avoiding the obstacles which can directly impact to chassis from below. Due to this project it helps to run vehicle in off-road condition

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