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DESIGN OF SUSPENSION SYSTEM OF ELECTRIC SOLAR VEHICLE

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Abstract

Suspension systems don't tend to get much publicity, but they're probably the most crucial factor in the day-to-day enjoyment of your car. Like most other components on a vehicle, manufacturers have taken many different approaches .when it comes to suspension design.Luxury cars are engineered for a comfortable ride, while sports cars need to corner at high speed. Trucks, on the other hand, need to carry heavy loads and may travel off the pavement.

Keyword : suspension system

1. INTRODUCTION :

Suspension in solar cars is not designed to provide a smooth ride. Soft suspensions waste energy by absorbing the motion of the car as it travels over a bump. Therefore, solar cars have a very stiff suspension, which is designed to prevent damage to the frame in the event of a large jolt. For the front wheels almost all solar cars use double A-arm suspension, in our design we are using a Short-Long Double A-arm suspension. The upper arm is shorter to induce negative camber as the suspension rise. When the vehicle is in a turn, body roll results in positive camber gain on the outside wheel. The outside wheel also rises and gains negative camber due to the shorter upper arm. The suspension design attempts to balance these two effects to cancel out and keep the tire perpendicular to the ground. This is especially important for the outer tire becauseof the weight transfer to this tire during a turn. Our car design uses long uprights mating onto high mounted wishbones reduces the thickness of the wheel fairings which lower drag. The wheel suspension is an integral part of every vehicle. Construction of wheel suspension connects wheel and frame. Suspension systems serve a dual purpose; they contribute to the cars road handling and braking for proper safety and driving pleasure and at the same time are well isolated from road noise, bumps, and vibrations. Load transfer occurs via suspension hard points to chassis and suspension plays a role in tire wear. These goals are generally at odds, so the tuning of suspension involves finding the right compromise. A dependent wheel suspension of vehicle is created of two wheels which are connected by axle bracket and together create solid

unit. Contrary the independent wheel suspension is characterized by independent wheel connection. This design enable weight reduction of un- sprung vehicle parts. Suspension system is referred to the springs, shock absorber and linkage that connect the vehicle to the wheels and allows relative motion between the wheels and vehicle body. Also, the most important role played by the suspension system is to keep the wheels in contact with the road all the time. One of the functions of suspension system is to maintain the wheels in proper steer and camber attitude to the road surface. It should react to the various forces that act in dynamic condition. These forces include longitudinal (acceleration and braking) forces, lateral forces (cornering forces) and braking and driving torque. It should resist roll of the chassis

2. Literature review

1. “ Design & Manufacturing Of All Terrain Vehicle (ATV)- Selection, Modification ,Static & Dynamic Analysis Of ATV Vehicle” , “ Upendra S. Gupta, Sumit Chandak, Devashish Dixit”, “ International Journal Of Engineering Trends And Technology (IJETT)”, – Volume 20 Number 3 – Feb 2015: The main objective of designed the controller for a vehicle suspension system is to reduce the discomfort sensed by passengers which arises from road roughness and to increase the ride handling associated with the pitching and rolling movements. This necessitates a very fast and accurate controller to meet as much control objectives, as possible. Therefore, this paper deals with an artificial intelligence Neuro-Fuzzy (NF) technique to design a robust controller to meet the control objectives. The advantage of this controller is that it can handle the nonlinearities faster than other conventional controllers. The approach of the proposed controller is to minimize the vibrations on each corner of vehicle by supplying control forces to suspension system when travelling on rough road. The other purpose for using the NF controller for vehicle model is to reduce the body inclinations that are made during

intensive manoeuvres including braking and cornering. A full vehicle nonlinear active suspension system is introduced and tested. The robustness of the proposed controller is being assessed by comparing with an optimal Fractional Order PIλDμ (FOPID) controller. The results show that the intelligent NF controller has improved the dynamic response measured by decreasing the cost function. A novel Neurofuzzy controller has been successfully developed for afull vehicle nonlinear active suspension system. The results have been compared with optimal FOPIDcontroller and thecorresponding system without controller. From these results, the NF controller has capability of minimizing the control objectives better than the optimal FOPID controller. The test of the robustness proves that the NF controller is still stable and it forces the cost function to be minimum even significant disturbances occurred. The results have been confirmed that when the NF controller has been used, the cost function is still away from zero while when the optimal FOPID controller is used the cost function has much bigger values.

2.“Modeling, Analysis And Control Of Active Suspension System Using Sliding Mode Control And Disturbance Observer”, “Faraz Ahmed Ansari, RajshreeTaparia”, “International Journal Of Scientific And Research Publications”, Volume 3, Issue 1,
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The purpose of this paper is to construct an active suspension control for a quarter car model subject to excitation from a road profile using an improved sliding mode control with an observer design. The sliding mode is chosen as a control strategy, and the road profile is estimated by using an observer design. The objective of a car suspension system is to improve
the quality without compromising the handling characteristic by directly controlling the
suspension forces to suit the road and driving conditions. However, the mathematical model obtained suffers from few uncertainties. In order to achieve the desired ride comfort, road
handling and to solve the uncertainties, a sliding mode control technique is presented. A nonlinear surface is used to ensure fast convergence of vehicle’s vertical velocity. The nonlinear surface changes the system’s damping. The effect of sliding surface selection in the proposed controller is also presented. Extensive simulations are performed and the results obtained shows that the proposed controller perform well in improving the ride comfort and road handling for the quarter car model using the hydraulically actuated suspension system. The main motivation for designing an active suspension system is to improve the ride comfort by absorbing the shocks due to a rough and uneven road. the response of passive suspension system for unit step and two bump road profile respectively. The Response of passive suspension system shows that the system is stable but need some time to settle down for unit step input and in case of two bump road disturbances; the passive suspension system could not attenuate the given force. This cause sprung mass deflection occur in the system. Active suspension will response much better than without observer and also passive suspension system. Passive suspension is the weakest suspension to absorb any disturbance exerted to the system. In this chapter the performance of proposed observer and SMC with disturbance observer has been investigated. It has been shown that the SMC with disturbance observer improved the ride comfort and road handling performances of quarter car active suspension system compared to passive suspension system with disturbance observer control technique. The proposed sliding mode control with disturbance observer is robust to various types of disturbance.

3 .Suspension system

Suspension in solar cars is not designed to provide a smooth ride. Soft suspensions waste energy by absorbing the motion of the car as it travels over a bump. Therefore, solar cars have a very stiff suspension, which is designed to prevent damage to the frame in the event of a large jolt.

For the front wheels almost all solar cars use double A-arm suspension, in our design we are using a Short-Long Double A-arm suspension. The upper arm is shorter to induce negative
camber as the suspension rises. When the vehicle is in a turn, body roll results in positive camber gain on the outside wheel. The outside wheel also rises and gains negative camber due to the shorter upper arm. The suspension design attempts to balance these two effects to cancel out and keep the tire perpendicular to the ground. This is especially important for the outer tire because of the weight transfer to this tire during a turn. Our car design uses long uprights mating onto high mounted wishbones reduces the thickness of the wheel fairings which lowers drag.

Front suspension system :

Double Wishbone Suspension System:

Double Wishbone Suspension System consists of two lateral control arms (upper arm and lower arm) usually of unequal length along with a coil over spring and shock absorber. It is popular as front suspension mostly used in rear wheel drive vehicles. Design of the geometry of double wishbone suspension system along with design of spring plays a very important role in maintaining the stability of the vehicle. This type of suspension system provides increasing negative camber gain all the way to full jounce travel unlike Macpherson Strut. They also enable easy adjustment of wheel parameter such as camber. Double wishbone suspension system has got superior dynamic characteristics as well as load-handling capabilities.

Rear suspension

Coil Spring:

A spring is an elastic object used to store mechanical energy. Springs are usually made out of spring steel. When a spring is compressed or stretched, the force it exerts is proportional to its change in length. The rate or spring constant of a spring is the change in the force it exerts, divided by the change in deflection of the spring. Spring is used in order to absorb shocks and for providing springing action for better comfort of the passenger.

4.SPECIFICATION TABLE

PARAMETER	VALUE
Front suspension	Double wishbone
Rear suspension	Coil spring
Materials (spring)	Cold drawn steel wire
Material(A-arm)	AISI1018
Wire diameter	10mm
Mean coil dia	60mm
Solid length	140mm
Free length	200mm
NO.of active turns	12
Motion Ratio	0.5
Stiffness	39.44N/mm
Upper arm	190mm
Lower arm	230mm
Usprung mass	50kg
Sprung mass	250kg
Roll center height	110mm

5. CONCLUSIONS

From our project we have concluded that double wishbone type independent suspension system is more suitable for our electric solar vehicle, and simple mounting of coil spring suspension system is suitable for rear wheels due to low weight of vehicle. We achieved good steering control , with this suspension system. With the help of suspension system we overcome various factors such a pitching , rolling and various forces produced by tires due to accelerating torque ,decelerating torque and braking torque.

6.REFERENCES

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