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To Evaluate the Rendition of Suspension Systems in Automobiles by a Subjective approach to Examine various Characteristics

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Abstract

Suspension system is an assembly of various elements connected together by some mechanical means to run the automobile without any haphazard on the road. There are suspensions attached to each and every wheel of the automobile, sometimes making the suspension autonomous. Generally heavy luggage vehicle like trucks are equipped with leaf springs while cars and latest bikes by Macpherson Strut assembly. Bikes can also be seen equipped with coil spring suspension system to make the automobile cost compatible. A literature review was undertaken on the suspension system to find out the recent technological developments, discoveries until now. In doing so, it was found out that all types of suspension systems design available contribute to one sole purpose i.e. to make the assembly small and robust. Many optimization software's and simulation software's are now in process to improve the effectively and efficiency of the suspension system.
Keywords: Suspension Systems, Automobile, Dampers, Damping, Hydragas, Suspension Forces

I. INTRODUCTION TO SUSPENSION SYSTEMS

Fig. 1: General Assembly of Suspension System

Suspension system in context to automobiles consists of a various elements in the vehicle working together for a smooth and comfort driving. Suspension system consists of pneumatic tire, spring coils, shock absorbers, dampers, and various other linkages that connect the wheel to the vehicle body to maintain a certain desired degree of freedom. Suspension systems plays a very important role in the smooth running of the automobile as it contributes to holding the vehicle with road, braking accuracy and precision, and maintaining the comfort ability of the vehicle occupants from road noise, bumps and vibration. The main purpose of using the suspension system in an automobile is to maintain a perfect contact of the road with the pneumatic tire. The luggage on the vehicle is also safeguarded by the suspension system. The front and rear design of the suspension system can be varied and not kept similar depending upon the desired situation.

II. LITERATURE REVIEW

As per the research paper published by Mohamed El Mongi Ben Gaid, Arben C¸ ela, R´emy Kocik, active suspension control system are used in today cars because of their ability to manage the compromise between ride comfort and vehicle road-handling. They constitute a typical example of distributed control systems. In their research paper, the ride controller part of an active suspension system is presented and evaluated, taking into account its distributed architecture. The simulations are realized with the Matlab/Simulink toolbox TrueTime, which allows the simulation of the controlled system, integrating simple models of its implementation (task execution, processor scheduling, network transmission...). They showed, through a simulation example, how implementation related parameters can have a considerable impact on the robustness of the controlled system.

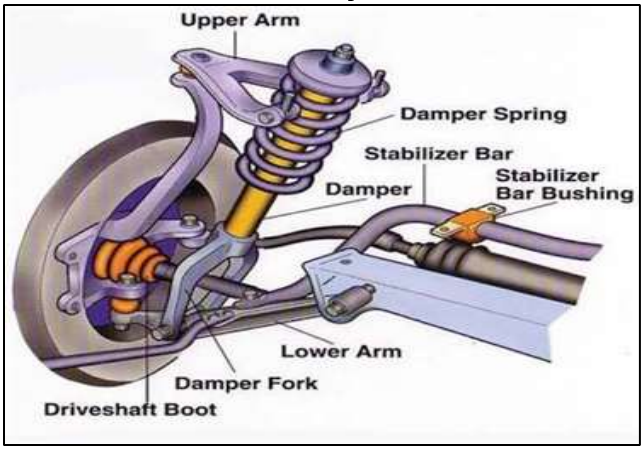

Fig. 2: Various Elements of Suspension System

Jimoh Olarewaju Pedro, Olurotimi Akintunde Dahunsi of South Africa states in his research that, presents the design of a neural network based feedback linearization (NNFBL) controller for a two degree-of freedom(DOF), quarter-car, servo-hydraulic vehicle suspension system. The main objective of the direct adaptive NNFBL controller is to improve the system's ride comfort and handling quality. A feed forward, multi-layer perceptron (MLP) neural network (NN) model that is well suited for control by discrete input-output linearization (NNIOL) is developed using input-output data sets obtained from mathematical model simulation. The NN model is trained using the Levenberg– Marquardt optimization algorithm. The proposed controller is compared with a constant-gain PID controller (based on the Ziegler–Nichols tuning method) during suspension travel set point tracking in the presence of deterministic road disturbance. Simulation results demonstrate the superior performance of the proposed direct adaptive NNFBL controller over the generic PID controller in rejecting the deterministic road disturbance. This superior performance is achieved at a much lower control cost within the stipulated constraints.

As per combined work of, Geoff Rideout of USA & Ronald J. Anderson of Canada, it was stated by them that in the field of Hydra gas suspension system that the Moulton Hydragas suspension system improves small car ride quality by interconnecting the front and rear wheel on each side of the vehicle via a hydraulic fluid pipe between the front and rear dampers. A Hydragas system from a Rover Group MGF sports car was statically and dynamically tested to generate stiffness and damping coefficient matrices. The goal was to develop the simplest possible model of the system for use in ride quality studies. A linear model showed reasonable accuracy over restricted frequency ranges. A second model used bilinear spring and damping constants, and was more accurate for predicting force at both the front and rear units for frequencies from 1 to 8 Hz. The Hydragas system static stiffness parameters, when used in the model, caused peak force under prediction in the jounce direction. The bilinear model required increased jounce stiffness to account for hysteresis in the rubber elements of the system, and dynamic fluid flow phenomena.

The research carried in Saudi Arabia by Ayman A. Aly & Farhan A. Salem on suspension systems confines that increased competition on the automotive market has forced companies to research alternative strategies to classical passive suspension systems. In order to improve handling and comfort performance, instead of a conventional static spring and damper system, semi-active and active systems are being developed. An active suspension system has been proposed to improve the ride comfort. A quarter-car 2 degree-of-freedom (DOF) system is designed and constructed on the basis of the concept of a four-wheel independent suspension to simulate the actions of an active vehicle suspension system. The purpose of a suspension system is to support the vehicle body and increase ride comfort. The aim of the work described in this paper is to illustrate the application of intelligent technique to the control of a continuously damping automotive suspension system. The ride comfort is improved by means of the reduction of the body acceleration caused by the car body when road disturbances from smooth road and real road roughness. The paper describes also the model and controller used in the study and discusses the vehicle response results obtained from a range of road input simulations. In the conclusion of their work, a comparison of active suspension intelligent control and classical control is shown in their paper.

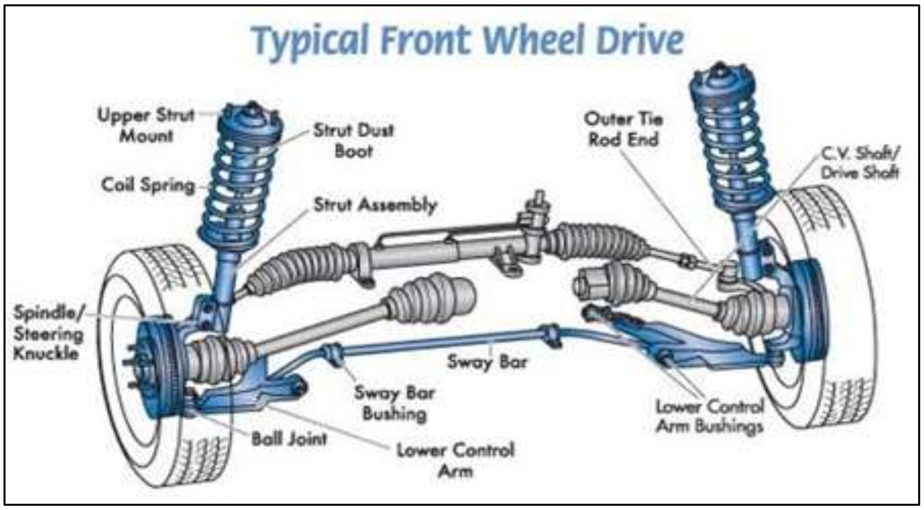

Fig. 3: Front Wheel Suspension system

T.P.J. van der Sande in his Master's thesis under guidance of B.L.J. Gysen in Eindhoven, 2011 stated that the main research goal of his thesis was to determine what performance gains can be achieved with a high bandwidth electromagnetic active suspension. As a baseline vehicle a BMW 530i is used, for which a retrofit electromagnetic suspension consisting of a spring and tubular permanent magnet actuator (TPMA) is designed. To design a control system for this actuator, a model of the BMW has been created, which consists of a quarter car model with variable sprung mass, damping coefficient and tire stiffness. As input to this model a road disturbance is used, that was modeled as a white noise source filtered by a first order low-pass filter. To test the performance of the actuator and controllers a full size quarter car test setup is used. With robust control an improvement of 48% in comfort can be achieved on the setup at the cost of an increase of 99.3% in dynamic tire compression. In terms of handling, an improvement of 17.7 % is achieved, worsening comfort by 10.7%. Frequency weighting clearly has a desirable effect, as comfort decreases by 6 % for the handling controller on rough road whereas sprung acceleration worsens by 75%. This means that all vibrations occur outside of the human sensitivity range. Deviations of the measurements from the simulations can be explained by stick slip friction in the suspension actuator as well as vibrations passing through the test setup.

From Electronics Department of University college of Engineering, RTU, Kota, India; Faraz Ahmed Ansari, RajShree Taparia tried 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 riding 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.

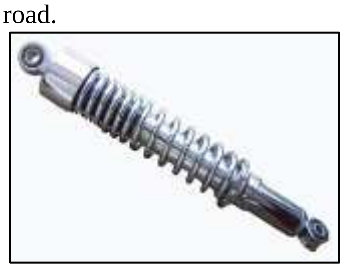
Fig. 4: Spring Damper

In the partial fulfillment of Master of Science Degree, Qi Zhou of Lehigh University in 2013 stated that suspension system is the most significant part which heavily affects the vehicle handling performance and ride quality. Because of its structures limit, the passive suspension system can hardly improve the two properties at the same time. Since the advent of active suspension system, it has become the research hot spot. The design of the control strategy is the core of active suspension system technology. So the research of the application of new algorithm and pavement feedback in automobile active suspension spreads out in this thesis. According to the automobile suspension system dynamic characteristic, this thesis use modern control theory in the active suspension system. The author puts forward new control strategies: new algorithm and pavement feedback, and combined with PID control, which make active suspension system control performance further improve. The author uses the vehicle kinematics theory to set up active suspension system dynamic model. The author also established integral white noise form of pavement input mathematics and simulation model. Through the Simulink software, simulation model was constructed. It achieved the control simulation with different input of the active suspension system.

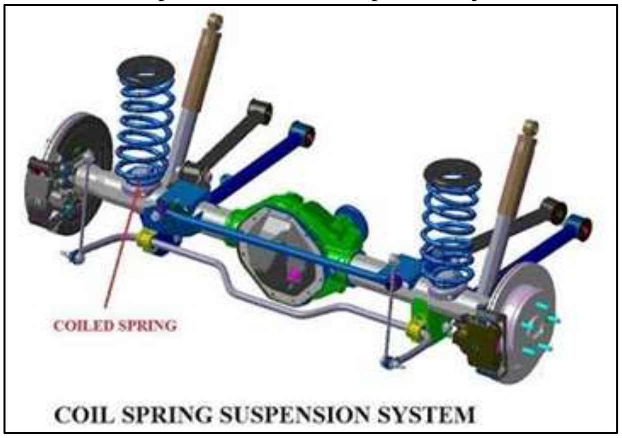

Fig. 5: Coil springs

According to A. Bala Raju and R. Venkatachalam, the suspension system of an automobile helps to support the car body, engine and passengers, and at the same time absorbs shocks received from the ground while vehicle moves on rough roads. The study of vibrations of the suspension system has been a topic of interest to many researchers in the past. Most of them have studied using quarter car model and half car model. These models represent the original system in an approximate way. Very few people have been working on full car model. Most of the literature presents the final results. The equations of motion together with development is missing in the literature, may be because of confidential nature of the work. Hence, in their paper it is aimed at deriving the equations of motion and study the vibrations of the suspension system under different disturbing conditions. The responses obtained are in close agreement with results present in their literature.

III. CONCLUSION

Thus study on suspension systems revealed that a lot of research and development is been in process all over the world since last decade. Now also various technological upgradation is on the on the way in the sector of suspension.

Various optimization processes are being applied on the design of suspension systems to make the whole assembly small, precise and compact. Hydraulic suspension systems are taking over the market in automobile sector.

Dampers play a very important role in maintaining the efficiency of the system. Shock absorbers used now a day's also have greater importance in the assembly.

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