Literature Review Adaptive Suspension Strategy for A Double Wishbone Suspension

Prof. Shaikh Samad[1], Shaikh Sahil [2], Mo Tauhid Alam[3], Zeeshan Ahmad[4], Mohd Ibran[5]
[1, 2,3, 4,5] Dept of Mechnical Engineering
[1, 2, 3, 4, 5] Everest College Of Engineering & Technology, Aurangabad , India Institute

Abstract- *A new familyofelectro-mechanical active suspensions that offers significant advantages with respect opassive and semi active suspensions, while at the same time avoiding the main disadvantages of alternative active solutions, is presented in this paper.These riesactive variable geometry suspension take saconventionain dependent passive or semiactive suspension as its starting point, and improves its behavior by actively controlling the suspension geometry with an electro-mechanical actuator. The advantages of this type of suspension are discussed and its simplest variant is studied in detail. Insight on the design process, as well as on the actuator modeling and selection is provided. Moreover, a control system for pitch attitude control of the chassis is presented. Simulation results obtained with a high-fidelity, full-vehicle, nonlinear model of a high-performance sports car that includes actuator dynamics and saturation limits are shown to confirm the potential of the proposed system.*

Keywords- About four key words or phrases in alphabetical order, separated by commas. Keywords are used to retrieve documents in an information system such as an online journal or a search engine. (Mention 4-5 keywords)

I. INTRODUCTION

Over the years, automobiles have been evolving continuously and went through a lot of developments. These developments are a result of advancements in technology, advanced manufacturing methods and the need to satisfy customer expectations.

Technological advancements in various automobile systems has been made possible by the incorporation of numerous mechatronic systems which resulted in better performance output . These include a myriad of changes from the incorporation of a basic windshield wiper to an exquisite interior with an air conditioning and infotainment system. Apart from the physical appearance of the vehicle, an important feature people delve for is enhanced comfort and safety in vehicles. The system that is majorly responsible for a vehicles' comfort level is the suspension system. The suspension system is an integral unit responsible for maintaining the stability of a vehicle under static and dynamic conditions . The suspension system plays a vital role in keeping the occupants comfortable by absorbing road shocks and vibrations and keeping the passenger cabin secluded. Without the suspension system, the vibrations and shocks would also be directly transferred to the steering, thereby making it extremely hard to control the vehicle. From its introduction in horse carts in the form of iron chains and leather belts to the present form, it hasbeen one of the most important systems which influenced the level of satisfaction of a consumer when he is inside the vehicle. Hence, the automotive industry strives to make efforts in improving it in every possible way. But any suspension system would face various challenges due to dynamic terrain conditions like uneven road surface, rolling, pitching, yawing, vehicle speed, load shifts and effect due to external forces like wind gusts that have always required the system to find the right balance between it self . To meet these performance requirements in the conventional system there is always a compromise between ride quality and dynamic properties. If a suspension system the operating parameters are tuned for optimum dynamic conditions might be too soft and the ride quality would decrease while improving the ride quality to satisfy passengers would reduce the vehicle maneuver ability characteristics. Hence, the packaging parameters of the suspension systems such as camber, caster, toe etc. must be set-up accordingly as they are responsible for the response of the system. By varying these parameters in an adaptive manner, the dynamic characteristics of the vehicle can be varied on a real-time basis. This lead to the development of advanced suspension systems that contain active components ranging from simple selflevelling suspensions to fully active systems. Active suspension is a type of automotive suspension that controls the vertical movement of the wheels relative to the chassis or vehicle body with an onboard data acquisition system and independent actuators. These active systems use the disturbances from the road condition.

Terrain as input to the electronic control unit (ECU) and the suspension system is tuned accordingly to achieve optimal performance in real time condition . The advantage of active suspension system is that its performance is optimized according to the dynamic road conditions thereby enhancing manoeuvrability and comfort on a real time basis, while in passive suspension systems the behaviour of suspension system is determined entirely by the system parameters and road surface. Implementation of electromagnetic controls to the suspension system gave engineers enhanced control over the vehicle dynamic characteristics . Various types of active suspension systems have been employed in higher end vehicles like Delphi's active suspension or Mercedes's Magneto-Rheological fluid (MRF) technology . However, these systems have high cost and are extremely complex because of the intricate technologies besides requiring very frequent maintenance. Hence, extensive research has been focused on developing active suspension systems that are economical but can adapt to dynamic road conditions. Adaptability to road conditions is achieved by varying the wheel parameters to suit the terrain and by varying them in real time, a dynamic control is achieved. Among the several parameters, camber and toe angle are two important attributes that maximize lateral grip and stability to a great extent. By varying these parameters the reaction of the vehicle can be optimized to the dynamically changing terrain which has been analysed and researched by various people in the past years.

II. LITERATURE REVIEW

Carlos Arana et al 2015 .A new family of electro-mechanical active suspensions that offers significant advantages with respect to passive and semiactive suspensions, while at the same time avoiding the main disadvantages of alternative active solutions, is presented in this paper. The series active variable geometry suspension takes a conventional independent passive or semiactive suspension as its starting point, and improves its behavior by actively controlling the suspension geometry with an electro-mechanical actuator. The advantages of this type of suspension are discussed and its simplest variant is studied in detail. Insight on the design process, as well as on the actuator modeling and selection is provided. Moreover, a control system for pitch attitude control of the chassis is presented. Simulation results obtained with a high-fidelity, full-vehicle, nonlinear model of a high-performance sports car that includes actuator dynamics and saturation limits are shown to confirm the potential of the proposed system.

B. Ashok 2016 et al Engine management systems (EMS) has become an essential component of a spark ignition (SI) engine in order to achieve high performance; low fuel consumption and low exhaust emissions. An engine management system (EMS) is a mixed-signal embedded system interacting with the engine through number of sensors and actuators. In addition, it includes an engine control algorithm in the control unit. The control strategies in EMS are intended for air-to-fuel ratio control, ignition control, electronic throttle control, idle speed control, etc. Hence, the control system architecture of an EMS consists of many sub-control modules in its structural design to provide an effective output from the engine. Superior output from the engine is attained by the effective design and implementation of the control system in EMS. The de- sign of an engine control system is a very challenging task because of the complexity of the functions involved. This paper consolidates an overview of the vital developments within the SI engine control sys- tem strategies and reviews about some of the basic control modules in the engine management system.

Y.Kawamotoa 2008 et al In this paper, the performance of the electro-mechanical suspension is discussed on the energy consumption, vibration isolation, and vehicle maneuver ability. On the basis of the formulation of electro-mechanical suspension, the energy consumption and vibration isolation are discussed through the contour maps with the sprung and unsprung mass velocity feedback gain axes. From the numerical simulation and experimental results, the contour maps for the evaluation of the performance with feedback gain axes are proposed, and on these maps, the abilities of vibration isolation and manoeuvr ability are evaluated.

Fig. 1 double wishbone suspension

On the energy consumption, the regeneration region exists, and the velocity feedback gain of un sprung mass should be considered for regeneration and energy saving. Moreover, Gain settings for improving each vehicle performance are proposed and verified by shaker tests. From simulation and experimental results, it is demonstrated that the proposed active suspension system is able to solve the compatibility between vibration isolation and energy saving. Bal´azsN´emeth 2015et al The tilting actuation of the front wheel improves the lateral dynamics of the vehicle and assists for the driver in a void in critical situations .The novelty of the method is the consideration of the non linear vities in the tyre characteristics .The tyre forces are approximated by polynomials, which are used in the lineari zing of the vehicle model. The proposed method improves the performances of vehicle dynamics, and handles the critical maneuvers cause.

Fig.2 Wishbone Arms

Fengchen Tu 2012 et al Magneto-rheological (MR) damper is an intelligent damper, which is used as automobile suspension for vibration semi-active control. A single piston rod MR damper with an accumulator was designed in order to satisfy with the demand of a certain automobile front suspension. The damper structural parameters were obtained by integrated optimal design combining magnetic circuit and structure. Magnetic circuit was analyzed by means of finite element method. The calculating formula derivation of damping force of MR damper with an accumulator was also achieved. Then the properties of designed damper were investigated by experiments, and the relationship between damping force, circuit and speed was fitted by the experimental results. This work provided promising method for the experimental study and design on automobile suspension made of MR damper.

III. DISCUSSION

Have focused their research on suspension arm designs and proposed a design based on topology with material optimization for controlling the arms in finite element analysis to improve the performance of the system. The review work postulates camber and toe as the two important performance parameters affecting vehicle handling characteristics and also determines the camber extremities as 5.5 degrees to 5.5 degrees. Arana et al. proposed a variable geometry suspension with an electro-mechanic actuator which controls the pitching of the chassis and the position of the upper-end eye of the strut system to improve suspension behaviour. The work successfully manages to reduce maximum squatting and diving angles

fig .3 front Suspension View

during transients by at least 30%. Groenendijk proposed an idea of active toe control based on signals from longitudinal and lateral acceleration, steering angle and yaw rate sensors in a 4-wheel individual steering control system. From the experiment, it has been concluded that toe-control improves vehicle handling behaviour and also decreases the vehicle side slip angle to achieve better dynamic behaviour of the vehicle. Shad, came up with the idea of mechatronic suspension system with multiple active degrees of freedom to actively change the camber, along with active steer and suspension system to increase the vehicle’s lateral forces. The work successfully improved vehicle’s lateral tire force by 28% enhancing the vehicle’s traction, leading to increased turning capabilities. Choudhery proposed the idea of variable camber suspension system using electro-mechanical devices to sense the lateral forces acting on the vehicle, and employs the camber adjusters to provide necessary response to improve vehicle stability during turns and cornering. Pourshams et al. came up with the idea of using a pneumatic system for providing the variations in camber angle of a double wishbone suspension system to improve traction and vehicle safety. The modelled system was able to adjust the camber angle from _5 to 5 degrees but their performance in dynamic conditions has not been evaluated. Esfahani et al. proposed the idea of varying the camber angle using hydraulic actuators to vary the geometry of suspension system components for better traction and stability. The system was able to provide the camber adjustment of _5 to 5 degrees with a short response time for improved adaptability. Nemeth and Gaspar presented the advantages of variable geometry suspension system, analysed the relation between steering and suspension and developed a control system to modify camber angle of front wheels during manuever.

Fig.4 Photograph of ATV wishbone arm

A change in camber angle is achieved through LPV methods and a change in yaw rate is also induced thereby improving vehicle stability. Nguyen et al. presented the application of linear parameter varying (LPV) based control system to differential brake moment and the auxiliary front wheel steering angle to change the camber angles of the wheels with 4 semi-active dampers in order to improve the tracking of the road trajectory. Nemeth et al. have proposed an LPV based control design for a variable geometry suspension system to reduce the lateral force during wheel tilting and the strategy incorporates the nonlinear tire characteristics.

fig .5 front Suspension View.

Tandel et al. have studied the implementation of a Proportional Integral Derivative (PID) controller on a suspension system with various combinations of spring parameters and damping constants to reduce the vertical body acceleration. It has been found that after PID implementation to control suspension parameters, the vertical body acceleration reduced by almost 50%. From various researches, it can be inferred that the active suspension control is accomplished by varying the camber, toe and damping coefficient of suspension system on a real time basis. By means of employing an electromechanical system, it is possible to achieve active camber control which results in improved vehicle stability and traction. Also, it can be concluded from various researches that active toe control helps in decreasing wheel slip rate thereby improving a vehicle's dynamic behaviour.

IV. CONCLUSION

Although there are several works in the field of active suspension system, very few work has been attempted to control the suspension system through a mechatronic system involving a PID controller and linear mechanical actuators. There have been several attempts to control toe and camber angles separately in anactive manner using several mechanisms with the objective of improving the vehicle dynamic characteristics. Past researches have proven the significance of an independent adaptive control system. However, the active control of camber and toe angles in a simultaneous manner has not been reported in any research work.

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