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DESIGN, ANALYSIS AND DEVOLOPMENT OF SUSPENSION SYSTEM FOR INCREASING STABILITY OF FOUR WHEELER – A REVIEW

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ABSTRACT:

This paper reviews the general study on the existing as well as conceptual configuration of the four wheeler suspension system and also a special case of train maneuverability. The suspension system is the most fundamental part of a car because it decides the on road behaviour of a car and also the response to the driving performance. With this article we are trying to combine the advantages of tilting ability of modern age trains with the four wheeler suspension system to have a better control while cornering. A great amount of exploration was done in the four wheeler industry to increase vehicle control and performance, but the answer to problem of vehicle handling in corners may exist in the study of modern superfast trains with tilting capability. Presently no four wheelers with such tilting ability are available to study the effects of C.G. shift in a car during cornering. This paper studies the wide literature available related to our research objective.

KEYWORDS: Maneuverability, Cornering, Suspension system, Tilting ability, Centre of Gravity.

I. INTRODUCTION:

A four wheeler suspension is the prime mechanism which separates the car body from the road and prevents the car from shaking itself into pieces. The most basic function of suspension system is to maintain the contact between tyres and road as well as to provide comfort to the passengers. During travelling on a straight road the car suspension mostly provides the riding comfort to the passengers but when the car leaps into the corner, various unbalanced forces come into the action trying to roll over the car body from its centre. This is actually prevented by the suspension system by balancing the net amount of centrifugal force with the traction force of wheels. While taking turn at higher speeds this entire phenomenon comes at risk and car may get out of drivers control, which in turn causes the accidental damage. The answer to this problem is our main concern and it will be completed by studying literature available on existing four wheeler suspensions and the modern age high speed tilting trains together.

II. REVIEW OF LITERATURE:

Ayman A. Aly, and Farhan A. Salem [1] studied the various kind of four wheeler suspension systems. According to the authors suspensions control is highly a difficult control problem due to the complicated relationship between its components and parameters. The researches were carried out in suspensions control systems cover a broad range of design issues and challenges. To improve handling and comfort performance, the conventional static spring and damper system has been replaced by semi active and active systems. The active suspension system has been suggested to improve the ride comfort. A quarter-car unit of suspension system is designed on the concept of individual and independent vehicle suspension arm. The soul part of a suspension system is to support the car body and to increase riding comfort.

R. Anbazhagan, B. Satish and K. Gopalkrishman[2]

They have developed a mathematical model for different vehicle movements in the lateral directions. They have also developed a program for the four wheeler stability analysis. In the highlight of their article they have worked on stability improvement and vehicle dynamics. They have also studied the current research going on improving software's for simulation of road conditions for improvement in stability and total control of the vehicle. This article have detailed study over the rollover stability, rollover is basically the rolling moment developed by the tyre side force and the centrifugal force due to acceleration in lateral direction. This phenomenon causes the instability and poor control over the vehicle while cornering. One more important thing is directional stability which depends on the horizontal plane movements applied to the four wheeler during various maneuvering and cornering conditions.

Prabu Krishnasamy, Jancirani Jayraj and Dennie John[3]

They have conducted an investigation report on an electrically controlled pneumatic suspension unit. This unit has been developed for increasing the passenger comfort using proportional integral derivative controller. Their study is based on the simulation and experimental values obtained in a lab based experiment. This article also represents the assumptions made to develop mathematical model and simulation model of the pneumatic suspension system. Also from the results obtained, the RZN control algorithm produces the lowest accelerations at the passenger seat. Considering the simulation and test results, the control algorithm used is effective and reliable for pneumatic suspension systems. All the other variables are found to be within satisfactory limits. Although the peak tyre travel is increased, it lasts for a very short duration in relation to the passive system. This finally results in better road holding conditions when the vehicle is going through the bump. Therefore, this article concluded that the active pneumatic suspension system including a PID controller certainly improves ride comfort without affecting road holding characteristics, as compared to the passive suspension system.

Rickard Persson[4]

Studied present technology working behind the modern high speed train technology. According to author, the tilting train technology has been introduced in modern trains to increase the passenger comfort as well as to reduce the time of travel between long distance journeys. The running times improve with increased cant deficiency, top speed and tractive performance; however the benefit of increased top speed and tractive performance is small above a certain level.

Trains with capability to tilt the bodies inwards the curve is a less costly alternative than building new tracks with large curve radii. The inside tilting action reduces the centrifugal force felt by the passengers, allowing the train to corner the curves at enhanced speed with maintained ride comfort. Trains capable to tilt the bodies inwards is often called tilting trains. Tilting modifications in a train has today become a trusted technology accepted by most manufacturers, but not favoured by many. Reduction of motion sickness may be important for the competitiveness of tilting trains. Reduced risk of motion sickness has a relation to comfort, one cannot be considered without also consider the other.

Mohamed El Mongi Ben Gaid, Arben C¸ ela, R´emy Kocik[5]

According to this article, Active suspension control systems are a typical example of distributed embedded control architectures. A spring, a shock absorber and a hydraulic actuator are the main components of an active suspension at each corner of the vehicle. Its role is to improve both driving comfort and road holding by appropriately transmitting and filtering all forces between the body of the vehicle and the road. To control an active suspension system, an amount of information which can be provided by a set of sensors situated in different locations in the vehicle is required. The authors performed various simulations in order to study the forces experienced by the active suspension system components. The simulations showed that the choice implementation parameters, especially those related to scheduling have an important impact on the robustness of the application in overload conditions. Those observations are the starting point of our future work, which aims at developing adaptive network scheduling algorithms, which take into account the states of both the network and the controlled system, to achieve optimal use of the available resources, especially in overloaded conditions.

Haider J. Abid, Jie Chen and Ameen A. Nassar[6]

This article focuses on the study of the air spring suspension system in relation to a passive suspension system. The simulation together with the optimization is used to obtain the air spring suspension model equivalent to passive suspension system, where the car body response difference from both systems with the same road profile inputs is used as the objective function for optimization (OptiY program). Volume of reservoir, length of surge pipe, diameter of surge pipe, initial pressure and volume of bag are the various parameters of air spring system. The simulation results show that the air spring suspension equivalent system can produce responses very close to the passive suspension system. In suspension design, a modern approach is used for the air spring units because of their ability of providing a controlled variable spring rate and they also offer inexpensive automatic levelling. One of the advantages of air springs is that the energy storage capacity of air is far greater per unit weight than that of mechanical spring material, such as steel. Due to the efficient storage capacity of potential energy inside springs of such type, their use in a vibration-isolation system can result in a natural frequency for the system which is almost 10 times lower than for a system employing vibration isolators made from steel springs. The ability to change the load carrying capacity simply by changing the air pressure rather than changing out the air spring is a major advantage that air springs have over steel springs.

M.H. ShojaeeFard, S. Ebrahimi Nejad, M. Masjedi[7]

Studied vehicle cornering stability and brake stabilization via bifurcation analysis. For vehicle

dynamics control, the yaw moment control is studied as an approach of controlling the directional motion of a vehicle during severe driving maneuvers. To meet this goal a control strategy based on the vehicle dynamics state-feedbacks, as well as an actuation system, is required.

This paper concerns with the optimal controller design for a nonlinear two-degree-of-freedom (2-DOF) vehicle directional dynamics model considering vehicle lateral velocity and yaw rate as state feedback variables. The focus of the paper is to design a state feedback control law based on stability regions obtained from bifurcation diagrams. The data of stability regions are obtained from a bifurcation of equilibrium analysis.

III. PROBLEM IDENTIFICATION:

By the detailed survey of different articles about four wheeler suspension systems and the new tilting technology implemented to modern high speed trains, we come to believe that the real problem behind the accidental turnover or body rollover is due to lateral shift in the position of centre of gravity of vehicle.

IV. PROPOSED SCHEME:

The proposed scheme involves following content:

- Calculating Lateral Shift in C.O.G
- Adaptive Suspension Arm Design
- Applying Counter shift Measures

V. CONCLUSION:

We learnt that we can combine both technologies for a new design modification in four wheeler suspension for increasing the corner safety and passenger comfort up to significant level. This adaptive design in suspension arms can be manipulated according to road conditions and speed limitations. Thus preventing the lateral shift in centre of gravity of vehicle making the cornering safe.

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