

Design of Four Wheels Active Steering

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Abstract— In this paper, four-wheel active steering (4WAS), which can control the front wheel steering angle and rear wheel steering angle independently, has been investigated based on the analysis of deficiency of conventional four wheel steering (4WS). A model following control structure is adopted to follow the desired yaw rate and vehicle sideslip angle, which consists of feedforward and feedback controller. The feedback controller is designed based on the optimal control theory, minimizing the tracking errors between the outputs of actual vehicle model and that of linear reference model. Finally, computer simulations are performed to evaluate the proposed control system via the co-simulation of Matlab/Simulink and CarSim. Simulation results show that the designed 4WAS controller can achieve the good response performance and improve the vehicle handling and stability.

Keywords: Four Wheels

I. INTRODUCTION

Steering is the term applied to the collection of components, linkages, etc. which will allow a vessel (ship, boat) or vehicle (car, motorcycle and bicycles) to follow the desired course. Four wheel steering, 4WS, also called rear-wheel steering or all-wheel steering, provides a means to actively steer the rear wheels during turning maneuvers. It should not be confused with four-wheel drive in which all four wheels of vehicle are powered. Four wheel steering is a method developed in automobile industry for the effective turning of the vehicle, increase the maneuverability and reduce the drivers steering effort. In city driving conditions, the vehicle with higher track width and wheelbase face problems of turning as the space is confined the same problem is faced in low speed cornering. The turning radius is reduced in the four wheel steering of the vehicle which is effective in confined space, in this project turning radius is reduced without changing the dimension of the vehicles. In situations like vehicle parking, low speed cornering and driving in city conditions with heavy traffic in tight spaces, driving is very difficult due to vehicle's larger track width and wheelbase. When both the front and rear wheels steer toward the same direction, they are said to be in-phase and this produces a kind of sideways movement of the car at low speeds. When the front and rear wheels are steered in opposite direction, this is called anti-phase, counter-phase or opposite-phase and it produces a sharper, tighter turn. Hence, there is a requirement of a mechanism which result in less turning radius and it can be achieved by implementing four wheel steering.

II. LITERATURE REVIEW

1) Dr.S.R. Shankapal (2013) developed a four wheel steering system for acar. Production cars are designed to understand and rarely do they over steer. If a car could automatically compensate for a over steer problem the driver would enjoy nearly neutral steering under varying

operations conditions. In situation like low speed cornering, vehicle parking and driving in city conditions with heavy traffic tight spaces. Driving would be very difficult due to vehicles larger wheel base and track width. Hence there is a requirement of a mechanism which results in less turning radius and it can be achieved by implementing four wheel steering mechanism instead of regular two wheel base.

- 2) Sathyabalan et al shows that the fabricated the four wheel steering can operate three mode operation. The project is to steer the vehicle according to the requirement. The four wheel steering is more required in critical roads and in desert roads. In this implementing three steering modes in a single vehicle and the modes can be changed as needed.
- 3) Jeong describes the vehicle modeling and dynamic analysis of four wheel steering system. The rear steering mechanism for the four wheel steering system vehicle was modeled and rear suspension was changed to McPherson-type forming a four wheel independent suspension system. Three different four wheel steering systems were analyzed. The first system serves a mechanical linkage between the front and rear steering mechanisms. The second and third systems used simple control logic based on the speed and yaw rate of the vehicle performance. Four wheel steering system vehicles proved dynamic results through double lane change test in a perfect way.
- 4) Dr.Dinesh.N.Kamble has developed a concept based on the analysis of the transmission mechanism of angle superposition with active front steering system. A controller of variable steering ratio for AFS system is designed and virtual road tests are made in car. The results of simulation tests validate the controller performance and the advantage of the variable steering ratio function, also show that the driving comfort is improved at low speed especially due to the active front steering system alters the steering ratio according to the driving situation.
- 5) P.A.Simionescu, Ilie Talpasanu (2006) synthesized the Ackermann linkage and steering control mechanism. And they concluded that it was required to maintain the steering error within acceptable values, so that the symmetric steering control is ensured for left and right of the vehicle. They used Nelder Mead simplex algorithm and AUTOCAD for their research.
- 6) Dilip S Chaudhary explains that a Four Wheel steering (4WS) System is also known as "Quadra Steering System". So both front as well as rear wheels can be steered according to speed of the vehicle and space available for turning. Quadra steer system will give full size vehicles greater ease while driving at low speed, and improves stability, handling and control at higher speed. Quadra steering system works in following three phases

Negative phase, Neutral phase, Positive phase. It enables the car to be steered into tighter parking spaces and makes the car more stable at speed (less body roll). It makes the car more efficient and stable on cornering, easier and safer lanes change when on motorways. The steering system allows the driver to guide the moving vehicle on the road and turn it right or left as required. The main concept is that when turning the vehicle, there should not require greater efforts on the part of the driver.

- 7) Pushkin Gautham shows that Selectable All Wheel Steering is a relatively new technology that improves maneuverability in cars, trucks and trailers. All wheel steering is used for parking and low-speed maneuvers but in this type of steering system the vehicle can be steered on both, two wheels & four wheels. The "Selectable All Wheel Steering" is the modified form of AWS (All Wheel Steering). The engagement and disengagement of the four wheels steering is done as per the driver requirement. This provides the benefits of both two wheel and four wheel steer. Thus, can be used as front wheel steer in long straight runs and can be used as all wheel steer when sharp and close turns are needed.
- 8) Lohith et al shows that the Four-wheel steering is a serious effort on the part of automotive design engineers to provide near-neutral steering. In certain cases like low speed cornering, vehicle parking and driving in city conditions with heavy traffic in tight spaces, driving would be very difficult due to vehicle's larger wheelbase and track width. Hence the requirement of a mechanism which results in less turning radius arises and it will be achieved by implementing four wheel steering mechanism instead of regular two wheel steering
- 9) Arun Singh, Abhishek Kumar, Rajiv Chaudhary, R. C. Singh, Four-wheel steering, 4WS, also called back-wheel Steering or all-wheel steering, provides a means to actively steer the back wheels during turning exercises. It should not be confused with four-wheel drive in which all four wheels of a vehicle are power-driven. It progresses handling and benefits the vehicle make tighter turns. Production-built cars incline to under steer or, in few occurrences, over steer. If a car could automatically compensate for an under steer /over steer problem, the driver would relish nearly unbiased steering under varying conditions. 4WS is a serious effort carried by automotive design engineers to provide near-neutral steering. The front wheels do most of the steering. Rear wheel turning is normally limited to partial during an opposite Direction turn. When both the front and rear wheels steer toward the similar direction, they are said to be crab steer phase and this produces a kind of sideways movement of the car at low speeds. But when the front and rear wheels are steer in opposite direction, this is called anti-phase, counter-phase or opposed-phase and it produces a shriller, tighter turn. This project aims at developing a 4 Wheel Steering System which would satisfy the needs of people. This system is employed to improve steering response, increase vehicle constancy while steering at high speed, or to decrease turning radius at low speed.
- 10) Bhishikar et al showed that standard 2 Wheel Steering System, the rear set of wheels are always directed

forward and do not play an active role in controlling the steering, While in 4 Wheel Steering System, the rear wheels do play an active role for steering, which can be guided at high as well as low speeds. Production cars are designed to under steer and rarely do them over steer. If a car could automatically compensate for an under steer/over steer problem, the driver would enjoy nearly neutral steering under varying operating conditions. In situations like low speed cornering, vehicle parking and driving in city conditions with heavy traffic in tight spaces, driving would be very difficult due to a sedan's larger wheelbase and track width.

III. CONCLUSION

This paper focused on a steering mechanism which offers feasible solutions to a number of current maneuvering limitations. Different mechanisms were adopted by trial and error method in order to facilitate the engagement of the wheels in the required direction, and the most convenient method was adopted. Thus the four-wheel steering system is a relatively new technology that imposes cornering capability, steering response, straight-line stability, lane changing and low-speed maneuverability in cars, trucks and trailers. The aim of 4WS system is a better stability during overtaking manoeuvres, reduction of vehicle oscillation around its vertical axis, reduced sensibility to lateral wind, neutral behaviour during cornering, improvement of active safety. Even though it is advantageous over the conventional two-wheel steering system, 4WS is complex and expensive. Currently the cost of a vehicle with four wheel steering is more than that for a vehicle with the conventional two wheel steering. Four wheel steering is growing in popularity and it is likely to have with all vehicles. As the systems takes over market the cost of four wheel steering will fall down.

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