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Four Wheel Steering Mechanism

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Abstract - The progress of automobiles for transportation has been intimately associated with the progress of civilization. The automobile of today is the result of the accumulation of many years of pioneering research and development. An attempt has been made in this project; the Automobile four wheels to act as a steering so that the u turn occurs very easily when compared to ordinary vehicles. Our foremost aim in selecting this project is to use a four-wheel two mode steering system by using bevel and spur gear mechanism. It is also good with regard to economic considerations and automobile applications. The most conventional and general steering arrangement is to turn the front wheels using a hand operated steering wheel which is positioned in front of the driver. The four-wheel two mode steering system is a modification for the present steering which is used for the improvement of easiness for vehicle handling. The four-wheel two mode steering system assists the driver by controlling the steering angle of vehicle's four wheels as the requirement of the driver, for making the parking and handling at congested areas easier. For meeting the application, the rear wheels steer in the same direction of the front wheels, allowing reduced turning radius or sliding of vehicle to sideways if we are able to transmit the motion that is given on steering wheel to the rear wheels and able to control like front wheels as our requirements, which is the basic idea of our project four-wheel three mode. In convertible four-wheel steering with two mode operation two steering modes can be changed as needed which assists in parking at heavy traffic conditions, when negotiating areas where short turning radius is needed and in off road driving.

Key Words*: *Automobile, Four-wheel, Steering

1. INTRODUCTION

Nowadays, the condition of increasing road traffic makes the handling of vehicles more difficult. The present scenario demands an exploration of new vehicle handling mechanisms, which in turn forces us to find an alternative way instead of the current system or a modified steering mechanism for better handling. While the vehicle enters a congested or narrow area there would be no one who doesn't wish for, if they would be able to reduce the turning radius of their vehicle or if they could move the whole vehicle sideways without turning the vehicle. Here, comes the application of Four Wheel Three Mode which provides the same by steering the rear wheels too as our requirement. It should not be confused with four-wheel drive in which all four wheels of a vehicle are powered. With the help of this system, the rear wheels also can be turned with respect to the direction of front wheels whenever required. The vehicle can be controlled more effectively especially during cornering, parking or when we get into a congested/narrow area. This system finds application mainly in off-highway vehicles such as forklifts, agricultural and construction equipment and mining machineries. It is also useful in passenger cars, mainly SUVs. 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 other arrangements are sometimes found on different types of vehicles, for example, a tiller or rear–wheel steering. Tracked vehicles such as tanks usually employ differential steering that is, the tracks are made to move at different speeds or even in opposite directions to bring about a change of course

1.1 Steering

The most conventional steering arrangement is to turn the front wheels using a hand–operated steering wheel which is positioned in front of the driver, via the steering column, which may contain universal joints to allow it to deviate somewhat from a straight line. Primary function of the steering system is to achieve angular motion of the front wheels to negotiate a turn. This is done through linkage and steering gear which convert the rotary motion of the steering wheel into angular motion of the front road wheels.

1.2 Problem Statement

Many four-wheel steering systems faded from popularity by the early 2000s, but the technology has made a comeback with modern machines such as the Porsche 911, Lexus LC 500, Mercedes-AMG GT R and GT C, Lamborghini Aventador, Ferrari 812 Superfast, Ferrari GTC4Lusso, and others. From the GMC Sierra, to the Honda Prelude, all-wheel steering has been offered in many different vehicles of all shapes and sizes for the past few decades. While

four-wheel steering is not a new concept in cars, it has seen a resurgence in the last few years. Four-wheel steering technology is beneficial because it increases the vehicle's steering response time and helps keep the vehicle stable at higher speeds. With all four wheels steering, instead of only the front two, this technology offers unprecedented control and manoeuvrability. That being said, 4-wheel steering takes some getting used to. Four-wheel steering systems, as safe and useful as they are, are typically reserved for higher-end makes and models. They require significantly more components and calibration than traditional steering systems, which comes at a price. Consider the vehicles that currently offer four-wheel steering as an example. Four-wheel steering is available on models from Audi, BMW, Lexus, Porsche, Lamborghini, Ferrari, Mercedes-Benz, and Acura. They're all Import vehicle manufacturers, which are generally more expensive to buy and maintain. We want you to know what you're getting into at Master Mechanic. Because four-wheel steering systems contain numerous mechanical and electrical components, if one fails, the entire steering system may be jeopardized. Four-wheel steering systems require more time to repair because they are more complicated. While these costs may not be a deal breaker for a Ferrari owner, they are something you should consider if the car is going to be your daily driver. There are many problems in big cities that the people face daily. Among them, traffic jams are one of the big problems. On almost every road, the volume of traffic has increased manifold. Especially in Mumbai, the traffic situation is getting worse with every passing day. Traffic snarls up every day and one of the causes of these traffic jams is an increase in the number of vehicles in the city. The flow of traffic is disrupted due to chingchi rickshaws, which are usually driven by underage drivers who often violate traffic rules and risk citizens' lives. If there is a traffic jam anywhere in the city, it presents the scene of a battlefront, where everyone desperately tries to reach their destination. It seems as if there is no think tank to foresee these problems. I request the departments of traffic and transport to make genuine efforts for improving the transportation and traffic system in Mumbai. It is high time that the government should pay attention to resolving the problem of traffic mess on our roads.

2. LITERATURE REVIEW

Soni Aayush, Adarsh Sahu, Prakhar Shrivastava, Dr. (Mrs.) Shubhrata Nagpal (2021) [1] Presently, all vehicles have a two-wheel steering system irrespective of the vehicle being front wheel driven, rear wheel driven or all-wheel drive. A four-wheel steering system known as "quadra steering" system is a system in which both the front wheels and rear wheels get steered according to the speed of the vehicle and space available for turning. This system makes the vehicle more stable and enhances its performance. In this report, the performance of the quadra steering system has been considered under low speed, medium speed and high-speed conditions. For parking and low speed conditions, rear wheels are turned in the opposite directions while at medium and high-speed conditions, rear wheels and front wheels are turned in the same direction. As a result, the vehicle becomes more stable and its turning radius reduces greatly. Mubina Shekh, O. P. Umrao Dharmendra Singh (2020) [2] Mostly, two-wheel steering (2 WS) systems are used to control the vehicle. But many researchers are working in this area, for a narrow space how a car can take a turn or back without any failure. There are different types of drives in a vehicle such as front-wheel, rear-wheel or all-wheel drive (2 and 4 WS). But for the reason of safety, four-wheel steering (4 WS) vehicles termed as Quadra Steering System are being used. In this paper, the features of different models of car steering system used have some drawbacks like failing at high speed, slipping of the tracks, and a higher turning radius. To overcome these drawbacks, a suitable and appropriate steering system has been proposed and it has been presented here. Seda POSTALCIOĞLU (2019) [3] The aim of this study is improving the vehicle safety and driver comfort. Four Wheel Steering (4WS) is used with Lane Keeping System (LKS) for confirming the efficiency of the integrated controller. A two-degree-of freedom model is used for simulation. Simulation is described for different driver models, different speeds on the vehicle with controllers. As seen from the simulation results, 4WS helps the vehicle not to swerve but increase lateral displacement and driver workload. LKS is used to solve this problem. 4WS is supported by LKS. System is evaluated using performance indexes.

Simulation results show that using the driver assistance systems together, improves vehicle. safety and driver comfort. T Liu1 , L N Jia , M N Yang, C S Li (2019) [4] Nowadays, people have higher and higher requirements on automobile performance. As an important performance of a vehicle, the handling stability not only affects the driver's driving experience, but also relates to the safety of the occupants. In order to improve the handling stability of vehicles, a simulation of the four-wheel-steering system in the linear range based on the time domain was conducted in this paper. Sideslip angle and yaw rate were taken as control targets. Proportional feedback control and PID control were integrated in the control system. The comparison of the front-wheel-steering system and the four-wheel-steering system indicated that the four-wheel-steering system had an obvious effect on improving the handling stability of the vehicle. Anurag Tirumala , & Anurag Josh (2019) [5], The objective of this paper is to assess the 4-wheel steering mechanism for automobiles. A Four-Wheel Steering mechanism, which is a new technology that improves handling in cars, & other four wheelers. In general, two-wheel steering vehicles, the rear wheels do not play any role in association with the

steering, they follow the path of the front wheels, this results in a large radius of turn. In a four-wheel system the rear wheels are made to turn left & right as per the requirements. With four wheels steering the rear wheels turn with the front wheels thus increasing the efficiency of the vehicle and decreasing the radius of turns, the performance of four wheels steer provides Control for parking and low-speed manoeuvres, the rear Wheel steer in the opposite direction of the front wheels, allowing much sharper turns. At higher speeds, the rest of the wheels steer in the same direction as the front wheels. The result is more stability and less body lean during fast lane changes and turns because the front wheels don't have to drag non-steering rear wheels onto the path. S. Sundar, T. Sudarsanan, Radha Krishnan (2018) [6], This review paper proposed the various methodology of the steering system in automobile industries. Most of the automobile industries prefer the Ackerman steering system. This review paper used to find out the research gap and implementation steps in a steering system. The steering system should have good vibration resistance, flexible rotation and ease of assembly. Four-wheel steering system has been developed through the study of previous work. Fei-Xiang Xu , Xin-Hui Liu , Wei Chen , Chen Zhou and Bing-Wei Cao (2018) [7], Considering the demand for vehicle stability control and the existence of uncertainties in the four-wheel steering (4WS) system, the mixed H2/H∞ robust control methodology of the 4WS system is proposed. Firstly, the linear 2 DOF vehicle model, the nonlinear 8 DOF vehicle model, the driver model, and the rear wheel electro hydraulic system model was constructed. Secondly, based on the yaw rate tracking strategy, the mixed H2/H∞ controller was designed with the optimized weighting functions to guarantee system performance, robustness, and the robust stability of the 4WS vehicle stability control system. The H∞ method was applied to minimize the effects of modelling uncertainties, sensor noise, and external disturbances on the system outputs, and the H2 method was used to ensure system performance. Finally, numerical simulations based on MATLAB/Simulink and hardware-in-the-loop experiments were performed with the proposed control strategy to identify its performance. Abe, Masato. (2018) [8], In this paper, a quasi-steady-state method is applied to four-wheel-drive (4WD) vehicles to study the effects of traction force distribution controls on the vehicle turning behavior during acceleration and power off braking. Solving the quasi-steady-state equilibrium equations, the steering wheel angle to turn with a certain turning radius of curvature with respect to lateral acceleration is obtained for various longitudinal acceleration to describe understeer/oversteer(u.s./o.s.) characteristics in acceleration and power off braking in a turn having the same implication as in a steady state turning. The optimum traction force distribution control having relation to tire vertical loads with additional rear wheel steer to attain vehicle turning behaviour which are insensitive to acceleration and power off braking as well as to get high acceleration capabilities is investigated. Peng Hang; Fengmei Luo; Shude Fang; Xinbo Chen . (2017) [9], Compared with the traditional front-wheel-steering (FWS) vehicles, four-wheel-independent-steering (4WIS) vehicles have better handling stability and path-tracking performance. In this paper, a novel 4WIS electric vehicle (EV) is proposed and it is viewed as a controlled object for path tracking. The nonlinear dynamical model of the 4WIS EV is built based on the nonlinear Dug off tire model. For controller design, the nonlinear dynamical model is simplified as a longitudinal displacement. The main objective of the MPC is to minimize the error between the reference signals and measurement signals. In the procedure of solving MPC, the constraints are taken into consideration including actuator constraints, tire slip angle constraints and the lateral acceleration constraint. To evaluate the performance of the designed controller, two simulation conditions are carried out using the nonlinear vehicle model with degrees of freedom (DOF) in MATLAB/Simulink. Simulation results show that the designed MPC has good path-tracking performance and strong robust performance against parametric perturbations. Ansari Rehan, Rafiuddin Khan, Ansari Sarfaraz, Shoaib Sayyed, Shaikh Abid, Karan K. Sharma (2019) [10], The objective of this paper is to analyse the steering mechanism of an automobile for the purpose of making a mechanism which is capable of turning all the four wheels of the automobile simultaneously whether in same or different directions as per the requirement so as to utilize the steering mechanism of the automobile in an effective way and to reduce the efforts applied by the driver to park the vehicle in a limited space or to reverse the vehicle direction. The steering mechanism plays a vital role to balance all the four wheels of the automobile while a vehicle moves in a definite direction. In this paper an attempt has been made to develop such a mechanism which can turn all the four wheels of automobiles simultaneously which could be beneficial to make an effective turn as well as can assist in parking the vehicles. The radius covered by the vehicle to reverse its direction by both two wheel and four-wheel steering mechanism has been calculated as well as experimentally evaluated.

3. OBJECTIVES

An innovative feature of this steering linkage design is its ability to drive all four Wheels using a single steering actuator. Having studied how 4WS has an effect on the vehicle's stability and driver manoeuvrability, we now look at what the future will present us with. Its successful implementation will allow for the development of a four-wheel, steered power base with maximum manoeuvrability, uncompromised static stability, front- and rear-wheel tracking, and optimum obstacle climbing capability. The advanced system of "Four-wheel steering" will work manually with the help of gears. The system will

control and direct the turning left and right of the rear wheels.

4. METHODOLOGY

After finalization of our topic the first step we did was to collect information regarding our project on the internet then we did a group discussion through telephonic conversation and planned on how to execute the project. We estimated the whole cost of the project which came around 4000rs/- so each member had to contribute 1000rs/- per person to make up the budget of the project. After receiving the money from each group member, we ordered components which were required to execute the project. While we were waiting for components to arrive through online shopping sites (amazon, flip kart) in the meantime we did the rough calculation & developed a timetable. Then with the help of pvc pipes we made the basic structure/frames of the vehicle. We fixed two bearings at the front and backside for connecting rods to rotate. We made a rough rack and pinion & mechanism arrangement for taking the measurements. After taking measurements we carefully started fixing the mechanisms (rack & pinion turning mechanism, sliding mechanism, etc.). After everything was in place checked weather, everything was working/moving properly. Then we made the sliding mechanism, for the tires to turn in the required direction. 4 small cycle tyres containing bearings were used. We installed tyres at the last stage of making the project. At final the shaft and tyre containing nut and bolt gets tighten in 4WS

5. DETAILS OF DESIGN

5.1 Components

The 4WS contains: -

1. PVC Pipe.

2. Small Cycle Tyre with bearings.

3. Rack & Pinion.

4. Bevel Gears.

5. Spur Gears.

6. Pipe Joints, Elbow Joints & T- Joints

5.2 Working

When the driver turns the steering wheel at low speeds, the front wheels turn in the direction of travel while the rear wheels also turn in the same direction, effectively reducing the car's turning circle. This makes low-speed manoeuvres quicker and easier.

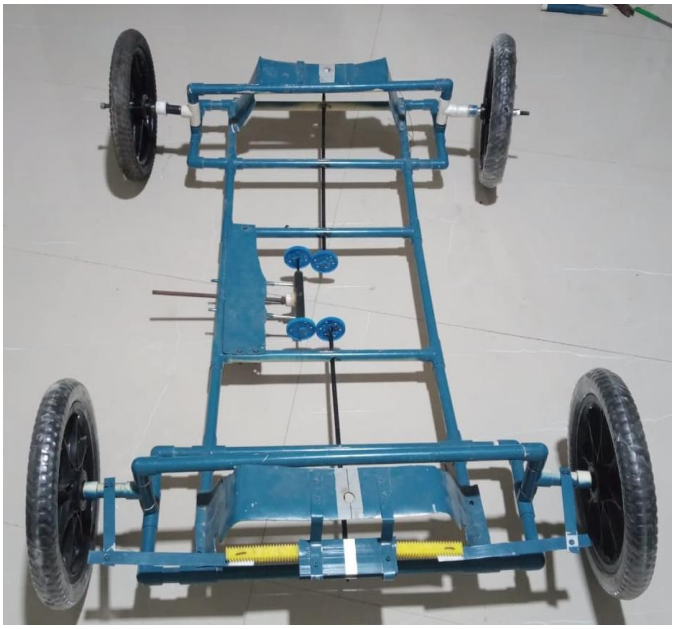

Fig. 1 Four Wheel Steering Mechanism

6. RESULT

Four-wheel steering system also known as Quadra Steering System controls all the 4 wheels while turning there are multiple components which are required for this steering system design. These are Rack and Pinion, Bevel Gears, Steering, Wheel, Hinge Joint, Spur Gear. The four-wheel two-mode steering system is an improvement over the current steering system that aids vehicle control. The four-wheel two-mode steering technology supports the driver by adjusting the steering angle of all four wheels to the driver's preference, making parking and maneuvering in congested locations more convenient. This four-wheel steering system operates in three modes which are

6.1 Negative Mode

In this mode both the front and the rear wheels of the vehicle move in opposite direction with respect to each other. This type of mode is useful for slow driving case and a steep curve or during parking of the vehicle as this requires very less space for turning of the vehicle as compared to other modes. This mode is very much beneficial where traffic is a big problem.

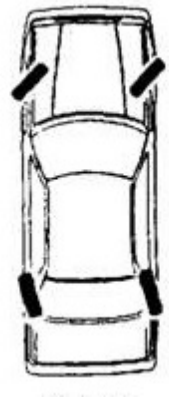

Fig. 1 Negative Mode

6.2 Neutral Mode

In this mode only the front wheels are steered and the rear wheels remain straight. This mode is simply the conventional steering mechanism.

6.3 Positive Mode

In this mode the front and rear wheels rotate in the same direction. This mode is very much beneficial for the lane changing during driving at comparatively higher speeds.

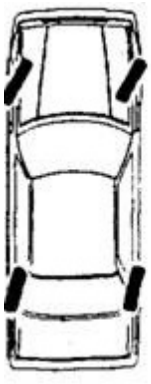

Fig. 2 Positive Mode

All these 3 modes can be brought in action as per our requirement. For this a lock nut can be provided in the main arrangement which will engage and disengage the positive mode or negative mode as and when required. When the lock nut is removed from the main arrangement the steering operation is carried out in normal conditions. In this normal condition only, front wheels will steer. When the lock nut is inserted into the engaging mechanism the other two modes can be used. When the locking nut is pushed to one position, the attached gears get engaged and the steering of rear wheel is provided in same direction as that of the front wheels. When the locking nut is pushed to other side secondary gears get engaged and the rear wheel steers in opposite direction to the front wheel. This results in negative mode steering.

Table-1: Technical Specification

Total length	40 inches
Total width	36 inches
Height of vehicle	30 inches
Radius of wheel	6.75 inches
Length of adjusting nut	12 inches

7 ADVANTAGES AND DISADVANTAGES

7.1 Advantages

1. Cornering Stability
2. Tighter Turning
3. Better on Tougher Terrains
4. Straight Line Stability
5. Changing Lanes

7.2 Disadvantages

1. Additional cost is required
2. Additional space is required to install this arrangement in vehicles

8. CONCLUSIONS

The steering mechanism's precise structure. We can change the design, performance, and efficiency based on the findings of the review. The four steering mechanisms can take use of the unique process as well as the safe environment. The four-wheel steering mechanism can be modified based on previous research and future goals. In order to achieve in-phase and counter-phase rear steering with regard to the front wheels utilizing pure mechanical linkages without requiring any electrical devices, we developed a revolutionary 4-wheel active steering mechanism that is feasible to build, quick to install, and highly efficient. This device aids in lane change at high speeds and better turning. It solves the challenges that come with sharp turns. It lowers the radius of the turning circle. It solves the challenges that come with sharp turns. It achieves neutral steering by reducing the car's turning circle radius and improving manoeuvrability and control while driving at high speeds. Furthermore, the components in this system are simple to build, the materials utilized are practicable, dependable, and readily available in the market, and the cost is quite low. The system is simple to assemble and light in weight, making it suitable for use in many types of vehicles.

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BIOGRAPHIES

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