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Four Wheel Steering System

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Abstract - *When we go to check the vehicles, most of the vehicles now a day are using two-wheel steering system. The problem in two-wheel steering system is that there is requirement of more turning radius to turn the vehicle. But if we talk about the efficiency we get to know that two wheels have low efficiency as compared to four-wheel steering system. So, if we use four-wheel steering system instead of two-wheel steering system we can improve efficiency as well as can decrease the turning radius of the vehicle. Four-wheel steering system is only method to overcome the problem of over-steering and under-steering. The purpose of this project to make all four wheels movable simultaneously. In this we have used linkage mechanism to move all wheels of the vehicle. We use Ackerman steering system at both front and rear wheel for steering system in the vehicle. We connect both the Ackerman steering by link mechanism to change the angle of rotation of vehicle.*

Key Words: **Four-wheel steering, Under-steering, Over-steering, Turning radius, 4WS**

1.INTRODUCTION

Steering is a method that is used to control the movement of vehicle but if we talk about the four-wheel steering system, we get to know that nowadays most of the cars are using two-wheel steering system. But as we compare it to Four-wheel steering system we get to know that the efficiency will be more in four-wheel steering system and we can get low turning movement by the help of four-wheel steering system. In four-wheel steering system, rear wheel also turns rather than just follow the front wheel. As in four-wheel steering system both front axle and rear axle moves as per the requirement of the operator of the vehicle. As in today's era we have seen that the places are quite small and there is less space on road where we have to drive the vehicle and so if we think over it we have to get something which uses less radius to turn and can easily turn when turning of the vehicle is required. So, we thought that to convert two-wheel steering system to four-wheel steering system so that we can overcome all the problems that are occurring in two-wheel steering system. Four-wheel steering is new technology related to steering system to improve the steering system in four-wheel vehicles. According to Saxena, Kumar, Luthra and Kumar (2014), by controlling the steering angle of all four wheels, this active steering system helps improve stability and response at high speed and helps reduce driver's steering workload at low speed.to achieve precise vehicle,

• Vehicles move smoothly and are easy to drive both in the city and on winding roads.

• Added stability means vehicles can be driven safely on expressways and when changing lanes.

• Quick and responsive control system will allow gentle steering operation.

According to Akhtar (2013), "The turning radius or turning circle of a vehicle is the diameter of the smallest circular turn (i.e. U-turn) that the vehicle is capable of making.

Turning circle radius = (track/2) + (wheelbase/ sin (average steer angle)".

1.1 Literature Review

Kumar and Kamble (2014) states that "At slow speeds, the rear wheels turn in the direction opposite to the front wheels. This mode becomes particularly useful in case of pick-up trucks and buses, more so when navigating hilly regions. It can reduce the turning circle radius by 25% and can be equally effective in congested city conditions, where U-turns and tight streets are made easier to navigate."

Lohith, Shankapal and Gowda (2013) found that "At high speed, when steering adjustments are subtle, the front wheels and the rear wheels turn in the same direction. As a result, the vehicle moves in a crab like manner rather than in a curved path. This action is advantageous to the vehicle while changing lanes on a high-speed road. The elimination of the centrifugal effect and in consequence the reduction of body roll and cornering force on the tire, improves the stability of the car so that control becomes easier and safer". He also found and revealed comparison with a conventional two-wheel steering system, the advantages offered by a four-wheel steering system include:

1. Superior cornering stability.

2. Improved steering responsiveness and precision.

3. High speed straight line stability.

4. Notable improvement in rapid lane changing maneuvers.

5. Smaller turning radius and tight space maneuverability at low speed.

6. Relative wheel angles and their control.

According *to Ruban, kumar, Shanmugavelan, Srinath and Ramesh (2017)*, the condition for perfect steering is "While taking a turn, the condition of perfect rolling motion will be satisfied if all the four-wheel axes when projected at one point called the instantaneous centre, and when the following equation is satisfied: Cotφ – Cotθ = c/b".

Bhishikar, Gudhka, Dalal, Mehta, Bhil, Mehta (2014) stated that "The 4WS system performs two distinct operations: in-phase steering, whereby the rear wheels are turned in the same direction as the front wheels, and counter phase steering, whereby the rear wheels are turned in the opposite direction. The 4WS system is effective in the following situations:

- Lane Changes
- Gentle Curves
- Junctions
- Narrow Roads
- U-Turns
- Parallel Parking

1.2 Problem Statement

When a car turns, inertia acts over the car and it apply a opposite force in the direction of the turn. This creates an uncomfortable feeling for both driver as well as for the passengers sitting in the vehicle. This depends on the nature of the turning of the vehicle, speed of the vehicle and dynamics of the vehicle. Our motive to design the steering system by taking all the aspects of the problems in vehicle and to overcome the problem being faced by the driver and passenger while the vehicle turning. Our primary aims it to develop the steering system which can offer a better turning movement of vehicle. This model will work on the real vehicle.

The model can be used to have a platform for further information, research and development.

1.2 Objective

In four-wheel steering system, two objectives are to be achieved. The first one is to develop a working model of four-wheel steering system. And second objective is that to learn the advantages and benefits of the four-wheel steering system with respect to two-wheel steering system. We also learn to make this possible by the help of kinematics of link mechanism.

2. COMPONENTS OF FOUR WHEEL STEERING SYSTEM

- Steering wheel
- Rack and pinion arrangement
- Front axle
- Rear axle
- Universal coupling
- Power transfer rod

3. WORKING AND OPERATION OF MECHANISM

As stated above that four-wheel will be move simultaneously by the help of kinematics of linkage. Four-wheel steering has been applied using Ackerman steering in both axles. As in front as well as in rear. As stated by Shakir, Mahadik and Singh (2017), "According to Ackerman steering system, geometric arrangement of linkages in the steering of a vehicle designed to solve the problem of wheels on the inside and outside of a turn needing to trace out circles of different radius. The intention of Ackermann geometry is to avoid the need for tires of slip sideways when following the path around a curve".So, we have make both rear wheel and front wheel movable by the help of Ackerman steering system and due to that we have also connected both these by the help of link that are further connected to motor. To give the turning to the vehicle. We have used motor in terms of steering because of the compact size of the modal. For turning or as we can also say that for turning we have use a DC motor in which gear are arranged to maximum torque can be exerted over the link to move the Ackerman Mechanism. We have use L type link to play the Ackerman mechanism and we connect a simple link to the L type link to make the mechanism free to more. And because of the link arrangement we have to make the mechanism possible to give high efficiency in terms of less power. So, we have design the Mechanism first and then we implement our idea over that. We have attached two DC motor to rear axle drive to provide equal movement to both the wheel so that forward and backward motion of the vehicle can be done. We have connected all the motor and arranged switched to provide the motion and turning by the help of circuit board. We used Iron Bar to connect link mechanism to each other and wheel that we use are of plastic and motor that we used in it are DC motor. With DC motors we connect a Gear Box to provide more torque so slide movement of steering can be done. As Photo of the linkage Mechanism if given below.

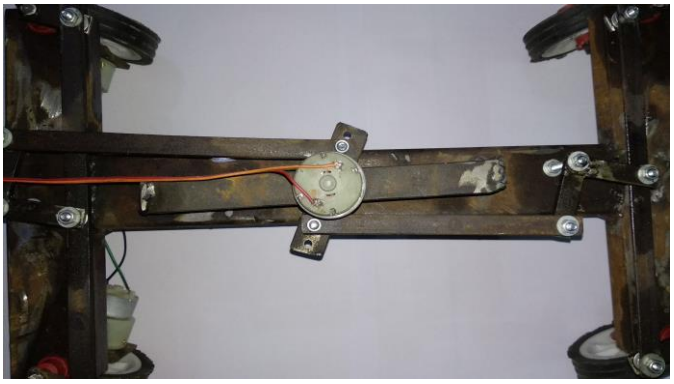

Fig -1: 4WS Link Mechanism

In Fig. 1 you can check the mechanism by which steering is done. As the motor which is connected in the middle with the link moves simultaneously other link also moves from which L Type Link also moves as shown in figure 2.

As this L type link moves that helps to move the Ackerman Steering system that will move to turn the vehicle according to the use of driver or as per the requirement of the driver to turn the vehicle and the Ackerman steering system for that is given in the Figure 3.

Figure 3 shows how the Wheel of this vehicle will move and this will be the system by which the wheel are tends to move. We have used DC Motor as shown in fig. 1 to give steering and the motor can run in clock wise direction as well as Anti clockwise direction so that the steering can be done as per the need of the driver. We can control this by the help of switches which we have connected to battery from the motor. As Opposite poles try to move motor anticlockwise and Correct poles moves the motor clockwise.

Fig -2: L type Link that moves Ackerman Steering

Fig -3: Ackerman Steering Linkage System

4. APPLICATIONS

According to Bevinkatti, Mali, Bayas, Ghadage and Anuse (2015), the application of four-wheel steering system is:

1. Parallel parking: Due to smaller turning radius the parking and un-parking of vehicle is easily performed towards the right or left side.

2. High speed lane changing: In this is less steering sensitive this does require a lot of concentration from driver since he has to judge the space and vehicles behind them.

3. Slippery road surfaces: Due to the rear wheel steering operation on low friction surfaces occurs hence vehicle direction easier to control.

4. Narrow Roads: Due to rear wheel steering on narrow roads with tight bends, counter phase steering reduces the turning radius.

5. U-Turns: By minimizing the vehicle's turning radius and counter phase steering of rear wheels enables U-Turns to be performed on narrow roads.

4. CONCLUSIONS

As focused on the project we have created an innovative four-wheel steering system which is easy to manufacture, and design is feasible to make. If compare to two-wheel steering system it is highly efficient in achieving low turning radius to overcome from the problem of oversteering, Understeering and counter steering. We achieve movement of rear wheel with respect to the front wheel by pure mechanical linkages without involving any electronic devices. This system can work in low speed and high-speed lane changing on the road or highway and better cornering. It can overcome from the problem that are facing by drivers at the sharp turning.

Table -1: Comparison between turning radius

COMPASION BETWEEN TURNING RADIUS		
Turning Radius	Four-Wheel Steering	Two-Wheel Steering
By Calculation	2.55 m	4.36 m
By Experiment	2.76 m	5.53 m

Table gives the comparison between the Four-wheel steering system and two-wheel steering system by Calculation as well as through Experimental result. It also helps to reduce the turning circle radius of the car and give good maneuverability. Moreover, the components used in this are very easy to manufacture, Material is easily available in market and Material that is used in this is feasible as well as reliable. Material used in this is available in market as quiet less cost. The linkage mechanism is easy to install and can be implemented in all types of cars efficiently.

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