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DESIGN AND DEVELOPMENT OF QUADRA WHEEL STEERING SYSTEM

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Abstract: Nowadays most of the four vehicles have two wheel steering systems for the movement of the vehicle. Quadra wheel steering is an effort to provide near-neutral steering. It will help in situations like low speed cornering, vehicle parking and driving in urban areas with heavy traffic in tight spaces as driving would be very difficult due to the vehicle's larger wheelbase and track width. Hence there is a requirement of a mechanism which gives outcome in less turning radius and it can be achieved by implementing Quadra wheel steering mechanism instead of regular two wheel steering which is followed by many of the automobile companies in the market.

The main goal of this project is to turn the rear wheels out of phase to the front wheels and to reduce turning radius. It consists of four bevel gears, four pillow block bearings ,intermediate shaft, square rod, electric motor, steering, battery and four tires.

Key words –Four Wheel Steering, Intermediate shaft, Wheels, Turning Radius, Rack and Pinion .

1. Introduction

Quadra wheel steering is a system developed in the automobile as well as the mechanical industry for the effective turning of the vehicle and to increase the manoeuvrability. This system focuses on making steering more smooth to rotate four wheels by using this mechanism. It goes for building up a counter stage wheel guiding in which rear wheels turn inverse way as compared to that of front wheels.

Fig.1 Front view of the model

This mode can be utilized to move the vehicle through a blocked city which consist of narrow lanes and restricted roads. Improved cornering is important and vehicles with Quadra wheel steering mechanism can move easily on constricted lanes.

At low-speed wheel movement is prominent so that rear wheels are rotated in opposite direction to that of the front wheels. At top-speed, when steering adjustments are narrow, the front wheels and rear wheels turn in the same direction. This action is beneficial to the car while changing lanes on a high-speed road.

As shown here we have made a negative phase mechanism in which the axles of both the front and the rear wheels move in opposite directions and relative to each other. This system is used often during parking of the vehicle. As both the axles move in different directions the radius of curvature while turning reduces. It shows that the vehicle will require less space for parking and this will be helpful in places where traffic and parking is a major problem.

2. Principle

Steering mechanism comprises of a rack and pinion set which is used to turn the wheels in the front and a bevel gear set is made just after the steering and power is transmitted through the transfer shaft to the gearbox assembly, and where the power is transmitted to the rear wheels.

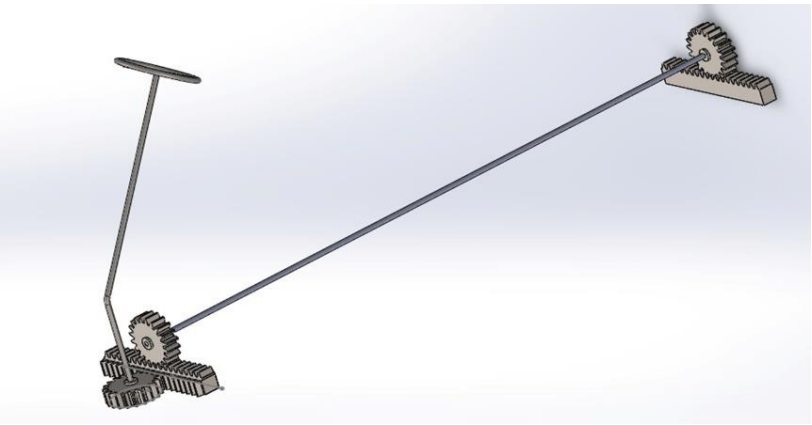

Fig. 2.1 Quadra Wheel Rack and Pinion Steering Mechanism

3. Problem Definition

Nowadays all vehicles use a two wheel steering system, but the efficiency of the 2WS system vehicle is proven to be low compared to the 4WS system car. So, this mechanism is based on how to prove that the Four wheel steering system is better than Two wheel steering system in terms of turning radius. A four wheeler with more turning radius faces many obstacles in parking and low speed cornering due to its higher wheelbase and track width but the commuter prefers the four wheeler to be higher wheelbase and track width as it gives good help while travelling.

Turning radius will be declined for the same vehicle of higher wheelbase. In this project a vehicle is considered and four wheel steering is implemented without substitution in dimension of the vehicle and reduction in turning radius is accomplished. It shows improved steering responsiveness and precision.

3.1 Comparison of 4WS system with 2WS conventional system

- Car is more efficient and stable on cornering
- Improved steering response
- High speed straight line stability
- Notable improvement in rapid , easier , safer lane changing manoeuvre
- Smaller turning radius
- Relative wheel angles
- Risk of hitting reduced

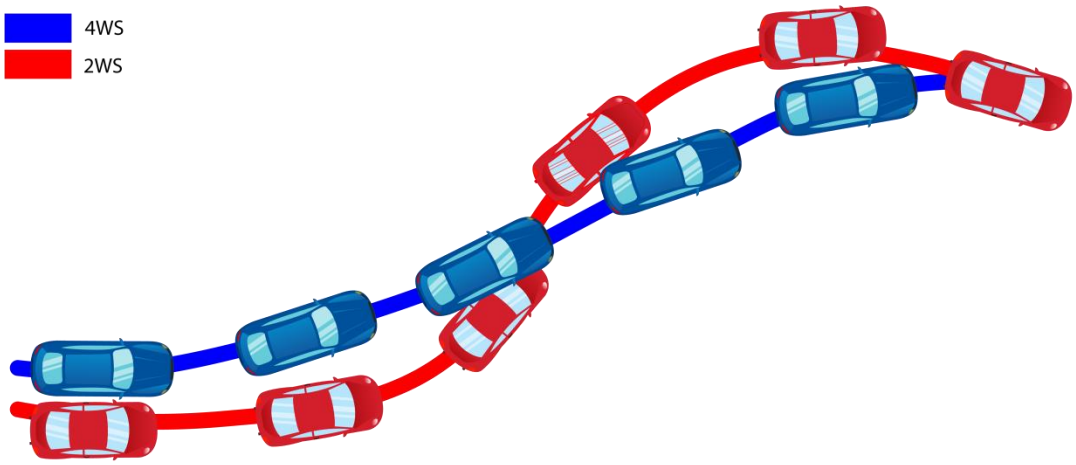

Fig 3.1 Comparison of 4WS system with 2WS conventional system

4. Design

The model is designed using the software solid works. It consists of four tires, shaft, 3 pairs of rack and pinion here we are placing four pillow block bearings which are set at front with steering shaft and the other at the rear with the intermediate shaft. Seating arrangement is placed between the rods of pillow block bearings. Here three bevel gears are considered, first one and second one is attached to the steering shaft of the front steering and the other bevel gear is attached to the intermediate shaft.

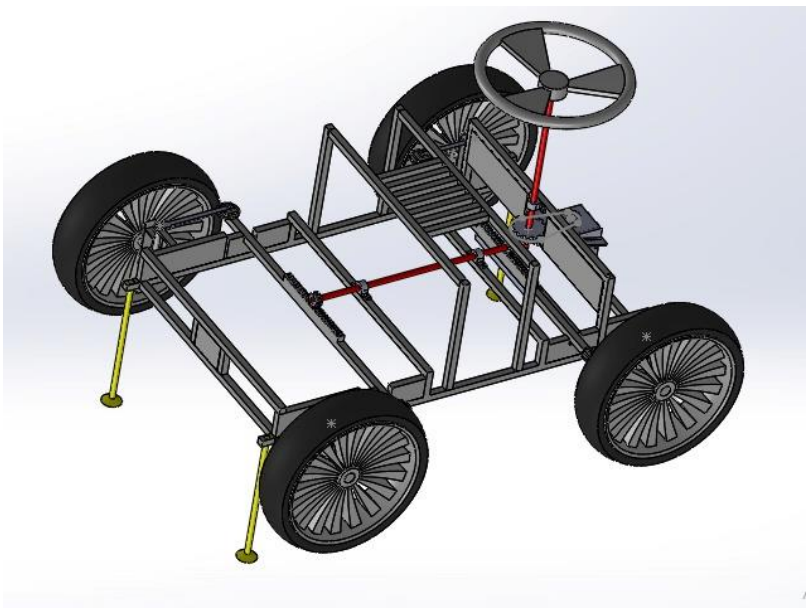

Fig. 4 Designed Model

The force is given at the steering wheel by the driver which rotates the steering column, as steering shaft rotates the gear attached to it will rotate, the other bevel gear coupled with the another one of steering column rotates in opposite direction with respect to the second bevel gear attached to the intermediate shaft, the shaft rotates in the direction of the second bevel gear. The rear steering column is attached with the intermediate shaft rotates as per the shaft such

that the rear wheels connected to the rear steering column rotates and the rear wheels rotates in opposite direction to the driver's movement of steering wheel.

4.1 Calculation

In this calculations, we consider the weight equivalent to a small size hatch back.
So, W = 650kg

Let's consider the system being employed in a front wheel drive vehicle. So, the weight distribution between front and rear axle with respect to front wheel drive mechanism is in the ratio of 55:45.

Hence,
Weight on front axle (Wf) = 357.5kg
Weight on rear axle (Wr) = 292.5kg

Dimensions obtained from the prototype models.
Wheelbase (L) = 1323 mm
Track width (T) = 1128 mm
Obtaining turning radius of the prototype model for standard 2-Wheel steering system,
$R = L/\sin \delta$
$= 1323/\sin 20^0$
$= 3868.19$ mm
$= 3.86$ m (approx.)

We know from that,
$R_2 = a_2^2 + R_1^2$
To obtain a_2,
$Wf = (W*a_2)/L$
$a_2 = (Wf\ L)/W = 727.65$ mm
From the above relation.
$R_1 = 3140.54$ mm

From the prototype fabricated the angles for each wheel is obtained.
$\delta if = 20.1^0$
$\delta ir = 12^0$
$\delta of = 20^0$
$\delta or = 12^0$
Finding instantaneous centres,
$\text{Tan } \delta if = C_1/ (R_1 – T/2)$
$C_1 = \text{Tan } \delta if \text{ x } (R_1 – T/2)$
$C_1 = 937.78$ mm

Since,
$C_1 + C_2 = L$
$C_2 = 385.21$ mm

$\delta if + \delta ir = \delta i = 40.1^0$
$\delta of + \delta or = \delta o = 24^0$

$\cot \delta = (\cot \delta i + \cot \delta o)/2$

= (cot 26.30 + cot33.1)/2

= 1.7165

$\delta = 30.220^0$

To obtain the turning radius of the vehicle we use

$R_2 = a_2^2 + L_2\cot^2$

R = 1509.90 mm

= 1.5 mm (Approx.)

Using,

$R^2 = a_2^2 + R_1^2$ and $\text{Tan } \delta_{if} = C_1/(R_1 - T/2)$

We get,

$R_1 = 782.25$ mm

$C_1 = 79.86$ mm

$C_2 = 1243.14$ mm

4.2 Comparison of Design Parameters of 2WS and 4WS

PARAMETER	2WS	4WS
δif (Degree)	20.1	20.1
δof (Degree)	20	20
δir (Degree)	0	12
δor (Degree)	0	12
R (m)	3.86	1.50
R1(mm)	3140.54	782.25
C1(mm)	937.78	79.86
C2(mm)	385.21	1243.14

5. Fabrication

5.1 Components

Base Frame, 3 Rack and pinion gear, Motor and Battery, Bevel Gear, Wheels, Pillow Block Bearing, Steering, Shafts, nuts and bolts and other miscellaneous items.

5.2 Final Fabrication : -

Fig 5.2 Final Fabrication

6. Working of the Mechanism

The four-wheel steering system consists of rack and pinion mechanism assisted by bevel gears of which is connected near the front wheels, steering rod in which input is given by the driver and another shaft will be connected to rear pinion. Rear wheel system consists of two racks and pinions. One of the racks will be in front of the rear wheel axis and the other one will be at the front axis. At lower speeds, the pinion will be in composite gear form in contact with rear rack so as to keep the wheels in motion.

Quadra wheel steering system depends upon the materials like pillow block bearings, shaft, square rod, rack and pinion. It consists of a rack-and-pinion front steering system that is assisted by a steering or switch connected with motor and battery which is our main power source.

7. Conclusion

- Working prototype was built to carry out the reduction in turning radius with four wheel steering when compared to two wheel steering.
- By the help of this Quadra wheel steering mechanism, it will help in parallel parking, U-turn, straight line stability, corner stability, good control of vehicle in the sudden situations.
- There is a 61.13% reduction of turning radius.
- It can be used in two different phases or modes like negative phase and positive phase.

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