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FABRICATION OF THREE MODE STEERING IN FOUR WHEELERS

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Abstract - The foremost conventional and general steering arrangement is to show the front wheels employing a hand–operated wheel which is positioned ahead of the driving force. The four-wheel three mode steering system could also be a modification for this steering which is used for the event of easiness for vehicle handling. The four-wheel three mode steering system assists driver by controlling the steering angle of vehicle's four wheels because the need of driver, for creating the parking and handling at congested areas easier. For meeting the appliance, the rear wheels steer within the other way or within the same direction of the front wheels, allowing reduced turning radius or sliding of auto to sideways. If we are ready to transmit the motion that's given on wheel to the rear wheels and ready to control like front wheels as our requirements, which is the basic idea of our project. In convertible four-wheel steering with three mode operation, three steering modes are often changed as needed which assists in parking at heavy traffic conditions, when negotiating areas where short turning radius is required and in off road driving.

***Key Words*:** Hand operated steering wheel, Turning radius, Transmission, Front and rear wheels, Convertible steering operation.

1.INTRODUCTION

Nowadays, the condition of accelerating road traffic makes the handling of vehicles harder. The present scenario demands a search of latest vehicle handling mechanism, which successively forces us to seek out an alternate way rather than current system or a modified steering mechanism for better handling. While the vehicle enters a congested or narrow area there would be nobody who doesn't wish for, if they might be ready to reduce the turning radius of their vehicle or if they might move the entire vehicle sideways without turning the vehicle. Here, comes the appliance of 4 Wheel Three Mode which provides an equivalent by steering the rear wheels too as our requirement. It shouldn't be confused with four-wheel drive during which all four wheels of a vehicle are powered. With the assistance of this technique, the rear wheels can also be turned with reference to the direction of front wheels whenever required. Thus, the vehicle are often controlled more effectively especially during cornering, parking or once we get into a congested/narrow area. This system finds application mainly in off-highway vehicles like 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 an equivalent direction, they're said to be in-phase and this produces a sort of sideways movement of the car. Other arrangements are sometimes found on differing types of vehicles, for instance, a tiller or rear–wheel steering. Tracked vehicles like tanks usually employ differential steering that's, the tracks are made to manoeuvre at different speeds or maybe in opposite directions to cause a change of course.

2.MODES OF STEERING

Through lever operation we can switch into different modes of steering. The lever is mounted on the steering wheel. Different modes of steering: -
1st mode operation is carried out in normal conditions.

2nd mode operation is carried out in heavy traffic congested areas and helps a lot in parking a vehicle.

3rd mode operation is carried out in slippery roads and hilly regions.

3.COMPONENTS AND WORKING

BEVEL GEAR

Bevel gears are a type of gears which intersects two shafts and the tooth-bearing faces of the gears are conically shaped. Bevel gears are most frequently mounted on shafts that are 90 degrees apart, but are often designed to figure at other angles also. The pitch surface of bevel gears may be a cone. Fundamental concepts in gearing are: -pitch surface and pitch angle. The pitch surface of a standard gear is that the shape of a cylinder. The angle between the face of the pitch and the axis is known as the pitch angle of the gear.

RACK AND PINION

Rack could be a rod or toothed bar which can be a thought of a sector gear with an in numerous large radius of curvature. Torque are spontaneously converted into linear force by meshing a pinion with a rack: whenever the pinion turns; the rack will be moving in a line. This sort of mechanism is employed in automobiles to convert the rotation of the wheel into the left-to-right motion of the tie rods.

Racks also feature within the theory of substance gear geometry, where, as an example, the tooth shape of an interchangeable set of gears could also be specified for the rack, and the tooth shapes for gears of specific or particular actual radii then derived from that. The rack and pinion gear type are employed during a cog railway. A rack and pinion are a pair of gears which convert rotational motion into linear motion. The circular pinion meshed teeth on a flat bar - the rack. Rotational motion applied to the pinion will result in the rack to maneuver to the side, up to its limit f travel. The pinion is in mesh with a rack.

Circular motion of pinion is now transferred into linear rack movement. In a rack and pinion system, the track rod is replaced with the steering rack which may be a long, toothed bar with the tie rods attached to every end. On the top of the steering shaft there's an easy pinion gear that meshes with the rack.

SPUR GEAR

Spur gears are the foremost common sort of gears. They had straight teeth, and it is mounted on parallel shafts. Sometimes, many spur gears are used directly to make very large gear reductions. This is because the spur wheel are often really loud. Every time if a gear tooth engages in a tooth on the opposite gear, the teeth collide, and this impact results in noise. It also increases the strain on the gear teeth.

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LEVER AND STEERING SYSTEM

The steering mechanism is to realize angular motion of the front wheels to barter a turn. This is done through linkage and gear which convert the rotation of the wheel into angular motion of the front road wheels. Secondary functions of the steering system are to provide directional stability of the vehicle when going straight ahead. To provide perfect steering condition, perfect rolling motion of the road wheels in the least time. To minimize tire wear. Till recently all vehicles were steered by turning the front wheels within the desired direction, with the rear wheels following. Lately all-wheel-steering has been designed and been employed in some selected vehicles. The steering mechanism consist of rack and pinion arrangements which are used to turn the wheels in front. A bevel gear arrangement is made just after the steering power is transmitted through the transfer shaft to the gear box assembly.

FRAME

It is made of mild steel material. The whole component used in the project is mounted on the frame.

DC MOTOR

A DC motor is an electrical device which comes under the category of rotary electrical motors that converts Direct Current (DC) electricity into energy. The most common types believe the forces are produced by magnetic fields. Nearly all sort of DC motors had some internal mechanism, either electronic or electromechanical, to systematically change the direction of current partially of the motor. DC motor is a primary sort of motor widely used around there, as they might be triggered or powered from existing direct-current (DC) lighting power distribution systems. A Direct Current's (DC) motor's speed are often controlled over a good range, using either a variable supply voltage or by changing the strength of current in its field windings. The universal motor can operate DC but may be a lightweight brushed motor used for portable power tools and appliances. Large size DC motors are currently utilized in elevator, hoists, propulsion of electrical vehicles, and in drives for steel rolling mills. The advancement in power electronics had made a replacement of Direct Current (DC)motors with Alternative Current (AC)motors possible in many applications.

ACKERMANN'S PRINCIPLE

Ackermann steering geometry may be a geometric arrangement of linkages within the steering of a car or other vehicle designed to unravel the matter of wheels on the within and out of doors of a turn wanting to trace out circles of various radii. The main aim of the Ackermann's steering geometry is to prevent the tires from sideway slips while travelling around a curve. The geometrical solution to the present is for all wheels to possess their axles arranged as radii of circles with a standard center point. As the rear wheels are fixed, this center point must get on a line extended from the rear axle. Axes intersects the front wheels on the line and it also requires the inside front wheel to be turned, while steering, through a higher or greater angle than its outside wheel.

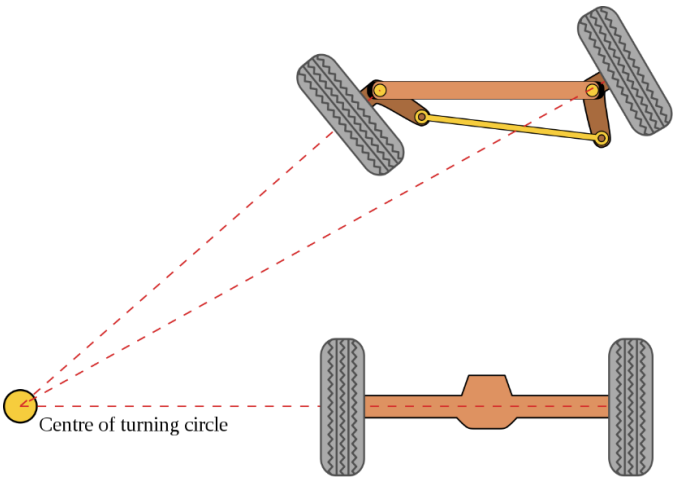

Fig -1: Figure

3.PRINCIPLE

The four-wheel steering system consist of rack and pinion mechanism assisted by bevel gear of which is connected to front pinion, steering rod in which input is given by the driver and other will be connected to rear pinion. Rear wheel system consists of two racks and pinions. one of the racks will be in front and rear wheel axis and other will be at front axis. Also, at any point in the system, one of the racks and pinion assembly will be engaged the other being disengaged. This change of angle is obtained by disengage and engage of gears and rack and pin. Rack and pinon for front and rear, identical geometry and components. Steering column is fitted with bevel gear meshes and transmits power to front and rear of the rack and pinion.

1st MODE OPERATION

The steering operation is administered in normal condition.

2nd MODE OPERATION

When the gear arrangement is pushed to at least one position, the bevel gears get engaged and therefore the steering of rear wheel is ensured and is in same direction as of front wheels.

3rd MODE OPERATION

The pinion and crown wheel disengages and therefore the pinion and crown wheel gets engaged. Due to spur wheel arrangement, the rear wheel steers in other way to the front wheel. This results in third mode steering. Three steering modes are often changed as required which assists in parking at heavy traffic conditions, when negotiating areas where short turning radius is required and in off road Driving.

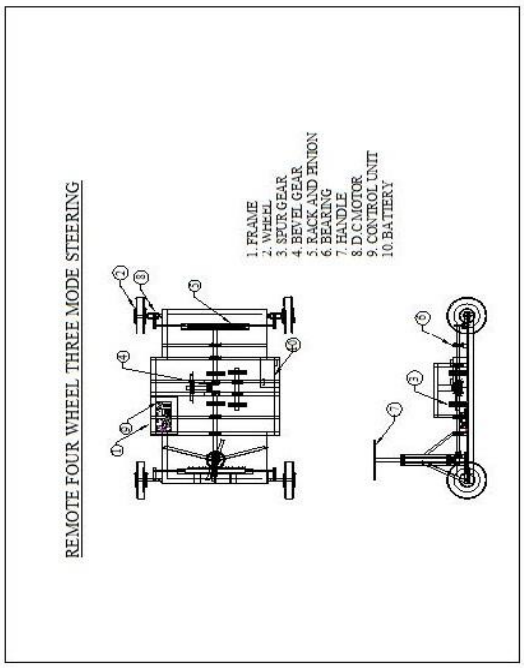

Fig -2: Figure

4.FABRICATION

These are secondary manufacturing processes where the starting raw materials are produced by anybody of the previous manufacturing processes desired. Its assembly involve joining pieces by either permanent or temporary. So that they might be perform the required function. The joining are often achieved by either or both of warmth and pressure joining materials. Many of the steel structure construction, we see are first rolled then joined together by a fabrication process: -

- Welding
- Drilling
- Cutting
- Grinding

5.STEERING CALCULATION

Steering effort is defined as the effort to be made by the driver in turning the steering wheel. This can be find out by either static condition or dynamic condition. Steering effort is maximum when the vehicle is stationary.

TURNING CIRCLE RADIUS

To Calculate the Turning Circle Radius, we did the theoretical calculations then verified the Radius of all the Wheels and the Turning Circle Radius of the Car through our draft.

Calculation of Inside Lock Angle of Front Wheels By Ackerman Mechanism, sin (Øf) =Y+X/R

Where, = Ackerman Angle if = Inside Lock Angle, Y = Arm Base, X = Linear Displacement of rack for one rotation of pinion, R = Ackerman Arm Radius

sin (13.640 +Øf) = 1.415+3.1/6 if =35.160

Therefore, Inside Lock Angle of Front Wheel is
R2=a2+R12…… (1)

Where, R = 5.394 m (Turning radius of the vehicle) a2 = Distance of CG from rear axle

R1 = Distance between instantaneous centre and the axis of the vehicle.To find a2

Wf = W*a2/L…….. (2)

Where, Wf = Load on front axle (On basis weight distribution)

W = Total weight of car L = Wheelbase Therefore,

a2=1.60m

Substituting the value of a2 in the above equation R1=5.15m. The axles,

From our standard calculations of 2 Wheel Steering, if = 35.160

tan if = c1 /R1 – tw/2……. (3)

Where, tw = Front track width

if = Inside Lock angle of front wheel Therefore,

tan 35.160 = C1 / 5.15*0.762 C1 = 3.09m

C1 + C2 = R …. (4) Where, C1 = Distance of instantaneous center from front axle axis

C2 = Distance of instantaneous center from rear axle axis

Therefore, C2 = 5.394 3.09 C2 = 2.304m

Therefore, from equation (3) and (4)

C1 = 3.09m C2 = 2.304m

to find of = outer angles of front wheel tan of =[C1/(R1+tw/2)]…….(5)

tan Øf=3.09/(5.15+0.762)

Øf=tan-7[3.09/(5.15+0.762)] of=27.590

to find ir = inner angles of rear wheel tan ir =[C1/(R1-tw/2)] ……. (6)

tan ir =2.304/(5.15+0.762)

ir =tan-1[2.304/(5.15+0.762)] ir =27700

to find or = outer angle of rear wheel tan or =[C2/(R1+tw/2)] ……. (7)

tan or =3.09/(5.15+0.762)

or =tan-1[2.304/(5.15+0.762)] or =21.290

CALCULATIONS FOR TURNING RADIUS FOR SAME STEERING ANGLE

To find turning radius, R R2=a22+L2(cot2) …… (8)

Where, = Total steering angle of the vehicle to find

cot= (cot +cot) /2……. (9)

Where, i= total inner angle of the vehicle o = total outer angle of the vehicle Therefore,

cot= (cot (35.160+27.700) + cot (27.590+21.290))/2

Therefore, substituting the above values in equation (8)

We put this above value of R in equation (1), to get the new value of R1, i.e.

R2= a2+R12

R1 = 1.84m (For the new value of R) Considering the turning radius as 2.44m, Further calculation for C1 and C2 from equation (3) and (4)

tan if = C1/(R1-(tw/2)) C1+C2=R

tan if = C1/(R1-tw/2) tan of = [C1/R1+tw/2)] tan if = [C2/R1-tw/2)] tan or = [C2/R1+tw/2)]

Øf=35.160(inside lock angle of front wheel)

Øf=16.980(outside lock angle of front wheel) ir=57.320(inside lock angle of rear wheel)

Ør=32.860(outside lock angle of rear wheel)

therefore,

= Øf+Ør (total inner angle of the vehicle)
=35.160+57.320=92.480

= Øf+Ør (total outer angle of the vehicle)
=16.980+32.860=49.480

From our draft we find the following values of Radius of All Wheels: Radius of inner front wheel (Rif) = 1.426m

Radius of outer front wheel (Rof) = 2.813m

Radius of inner rear wheel (Rir) = 2.185m

Radius of outer rear wheel (Ror) = 3.264m

Assuming the above values, we plotted a part modelling of Ackerman Steering Mechanism of our benchmark vehicle (Honda Civic) and we found that the Turning Circle Radius of our vehicle is reduced to 1.84m. Therefore,

cot=(cot92.480+cot49.840)/2 cot=0.400

Therefore, substituting the above value in equation (8)

The Turning circle radius of whole car=1.92

CALCULATION OF STEERING RATIO

Steering Ratio of car is calculated by the following formula:

R=steering wheel/no of degrees of deviation

Where, R = radius of curvature (same as units of wheelbase) = 1.92m = 75.59

s = wheelbase = 105.1

a = steering wheel angle = 3600 (assumed for one rotation of steering wheel)

n = steering ratio

Thus, the steering ratio of our car is 8.177:1, i.e. for 8.177° of rotation of steering wheel the tire is turned by an angle. Thus, from the above obtained value of Steering Ratio, we can conclude that driver has to apply less effort to turn the car, giving much better maneuverability and control on the car.

CONCLUSIONS

Ackermann's Steering Mechanism With perfect Ackermann, at any angle of steering, the center point of all of the circles traced by all wheels will lie at a common point. But this might be difficult to rearrange in practice with simple linkages. Hence, modern cars do not use pure Ackermann steering, partly because it ignores important dynamic and compliant effects, but the principle is sound for low speed maneuverer the turning circle of a car is that the diameter of the circle described by the surface wheels when turning on full lock. There is no hard and fast formula to calculate the turning circle but you'll get accessible using this.
We make this project entirely different from other projects. Since concepts involved in our project is entirely different that one unit is employed to varied purposes, which isn't developed by any of other team members. The project administered by us made an impressing task within the field of automobile industries. It is very usefully for driver while driving the vehicle. This project has also reduced the value involved within the concern. Project has been designed to perform the entire. It shouldn't be confused with four-wheel drive during which all four wheels of a vehicle are powered. With the assistance of this technique , the rear wheels can also be turned with reference to the direction of front wheels whenever required. Thus, the vehicle can be controlled more effectively especially during cornering, parking or when we get into a congested or narrow area.

REFERENCES

1.Mitchell A. Miller, Brian L. Steward "Control and Evaluation Methods for Multi-Mode Steering" Iowa State University, bsteward@iastate.edu. July 2002

2. K. Lohith, Dr. S. R. Shankapal, M. H. Monish Gowda "Development of Four-Wheel Steering System for a Car" Volume 12, Issue 1. April 2013

3. Dr.P.Sathyabalan, R.Sivaprakasam, A.Vijin Prabhu, G.sundaram "Designing and Fabrication of Multiple Mode Steering System" Vol. 2, Issue 12. December 2013

4. Sachin Saxena1, Vinay Kumar, Sarabjeet Singh Luthra and Alok Kumar "4 Wheel Steering Systems (4WAS)" ISSN 2278 – 0149 www.ijmerr.com Special Issue, Vol. 1, No. 1, January 2014

5. Dilip S Choudhari "Four Wheel Steering System for Future" ISSN 2278 – 0149 www.ijmerr.com Vol. 3, No. 4, October 2014

6. Chanpreet Singh, Dr.Rupesh Gupta, Himanshu Jindal, Rajeev Kumar Dang "Prototype of Four Wheel Steering System" Volume : 4 | Issue : 10 | Special Issue ISSN No 2277 – 8179. October 2015

7. Amandeep, Atul Kumar Kaushik, Vikas Acharya, Anil Kumar Dahiya "Four Wheel Steering System for Automobiles" Volume 5 Issue III, IC Value: 45.98 ISSN: 2321-9653. March 2017

8.Rithvik M S, Hari Vignesh B, Kavin S K, Yazharasu "Four Wheel Three Mode Steering System" Volume: 05 Issue: 03. March 2018

9.Syed Siraj Ahmed, Muhammed Danish Iqbal, Qazi Fahad Siddiqui, Shahnawaz Hussain Siddiqui, Mirza Zulfiqar Ali "Four-wheel three mode steering system" ISSN: 2455-4197 Volume 3, Issue 5. September 2018

10. XU FeiXiang, Liu XinHui, Chen Wei, Zhou Chen "Dynamic switch control of steering modes for four wheel independent steering rescue vehicle" Grant No. 2016YFC0802904

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