

## FOUR-WHEEL STEERING MECHANISM - REVIEW

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### ABSTRACT:

**This paper deals with, the problems involved in two-wheel steering mechanism and how those can be overcome by implementing four-wheel steering mechanism. India's terrain varies widely, a typically used two-wheel steering system is less stable than four-wheel steering system which is best equipped while dealing with it[1]. It advances its stability and control at higher speed, neutral steering, maneuverability, turning radius. In this paper efforts are made to make a cost effective and efficient mechanism of four-wheel steering using rack and pinion and an intermediate shaft. It allows the driver to change from two-wheel to four-wheel according to its requirement.**

**KEY WORDS: two-wheel steering, four-wheel steering, rack and pinion, maneuverability, intermediate shaft, over steer, under steer.**

### 1. INTRODUCTION:

Widely used two-wheel steering system lags in stability during high speeds, lane changing becomes a difficult task, it also faces problem while parallel parking. Since the front wheels are over burdened, as engine is placed at frontier position, due to these front tyres wear out quickly. As wheels are overburdened, it tends to under steer. While a heavy front provides adequate starting torque on wet roads, in all other conditions torque from a front wheel steer vehicle is inferior to a rear wheel steer vehicle. This is due to non-uniform weight distribution. The rear end of a front wheel steer vehicle is considerably lighter than its front end, which means the rear tyres do not grip the road very well. Since steering and engine power is handled by the front wheels, the latter sometimes tends to compromise the

former. The force generated front the engine, sometimes tends to pull the either to the right or to the left. This is referred to as torque steering.

According to news published in The Economic Times dated 28.dec.2016 which clearly stated that India ranks first in Road deaths in the world, where India accounts for 10 percent of global road accidents with more than 1.46 lakh fatalities annually, highest in world [2]. By research done by NPTEL, Bank Bazar, Low man law firm mechanical failure that causes road accidents reports steering system to be on third position [3]. Mumbai-pune expressway road accident study conducted by JP Research India concluded top contributing factors influencing occurrence of accidents.

TABLE 1: THE TOP CONTRIBUTING FACTORS INFLUENCING OCCURANCE OF ACCIDENTS

Human (93%)		Vehicle (12%)	
• Speeding (40%)	• Lane changing (30%)	• Defective Tyres (7%)	• Brake fade (2%)
• Driver sleep/fatigue (27%)		• Absence of reflectors (2%)	

which stated speeding and lane changing together contributes about 70%.

Thus, there is a need to develop a four-wheel steering mechanism that can eliminate these factors and increase efficiency in driving.

Many top models of cars like Mazda 929, Nissan skyline, Honda, etc. have put forth their technology and successfully designed and established four-wheel steering mechanism for their cars. These mechanisms are combination of electrical, electronic and mechanical systems[4]. Some consisting of bevel gear arrangement, thus cost of such systems is high and cannot be opted by the average range vehicle that rides on the road.

Many other researchers have provided the solution by giving all wheel steer, which does not fulfill the purpose. Another concept is also placed which is designed for optional four-wheel steering to normal two-wheel steering with the use of bevel and heavy steering system changing assembly, which made it costly and not user-friendly.

## 2. LITERATURE REVIEW:

The four-wheel steering mechanism is developed so that both front and rear wheel actively participate during turning, lane changing. The four-wheel steering system can be developed in three different systems are:

1. Mechanical four-wheel steering
2. Hydraulically four-wheel steering
3. Electro-mechanical four-wheel steering

Different mechanical based four-wheel system already existing in vehicle is:

The bevel gear is used in the four-wheel steering mechanism. As two bevel gears are considered, one bevel gear is attached to the steering column of the front steering box and the other bevel gear is attached to the intermediate shaft [3]. Use of bevel gear causes system more expensive, while it should be precisely mounted to avoid wear of tyre. Along with bevel gear universal joints with steering knuckle are used.

The bigger bevel gear mounted on a hollow shaft which is extended up to rear rack and pinion assembly connected by means of universal coupling. Hence, rotary motion is transferred from front to rear pinion shaft. On this shaft a Mechanism is fitted at mid which will help to make and break the rotary motion between front and rear to achieve two modes of steering i.e. Two-wheel steering and Four-wheel steering [4].

Universal joints may cause wear if joint is not properly lubricated and it should be maintained. Another mechanism used the wheels are steers by using chain drive mechanism. In the chain drive mechanism, two sprockets are involved which can be connected by chain. In two sprockets, one is bigger than other. Bigger sprocket is attached to rear pinion shaft and smaller is mounted on the front pinion shaft [5]. Due to a greater number of components it will be complex in construction.

So, to overcome this problem we use mechanism of spur gear for efficient cost, it also reduces fluctuating motions and easy to construct.

We have made 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 move. [6] use of DC motor cannot use is hazardous & explosive conditions. Its initial cost is also high. It also makes the design heavy and robust in construction.

When the steering is steered the power is transferred to the front rack and pinion steering gearbox, and a bevel gear arrangement is made to transfer the power to the rear rack and pinion steering gearbox. Bevel gear is used to transmit the rotary motion perpendicularly, so the one bevel gear is introduced in the front steering rod. Other bevel gear is connected to the transfer rod. Two supports are used to support the transfer rod. Transfer rod is connected to the rear rack and pinion steering gear box. Rear rack and pinion steering gear box is fixed to the car body by bolts and nuts and the ends of the steering box are connected to the rear wheel hub where the tyres are mounted. As the steering is steered the rear wheels also turn by the arrangements made and the rear wheel turn in the opposite direction by the arrangements in the bevel gear. [7].

The vehicle comes in a situation where it needs all the four wheels to be coupled to the front steering wheel, a lever is provided next to the driver seat so as to engage the rear steering mechanism to the front steering mechanism by pulling up the lever. Thus this engaging lever engages the front steering wheel to rear steering mechanism by the mechanical linkages provided in-between these two steering mechanism. Once the all four wheels of the vehicle get coupled to the steering wheel the steering wheel does its function and makes all the four wheels of the vehicles to steer simultaneously and the operation of four-wheel steering is performed. Once this process is over the wheels are brought back again to the straight position and the lever is pulled down to disengage the rear steering mechanism with the steering wheel and the vehicle again becomes a normal two wheel steering system. [8] Due to mechanical linkages it can cause more vibration and noise to driver. It can't be adjusted. It also developed wear and backlash.

## 3. PROPOSED DESIGN FOR FOUR-WHEEL STEERING MECHANISM:

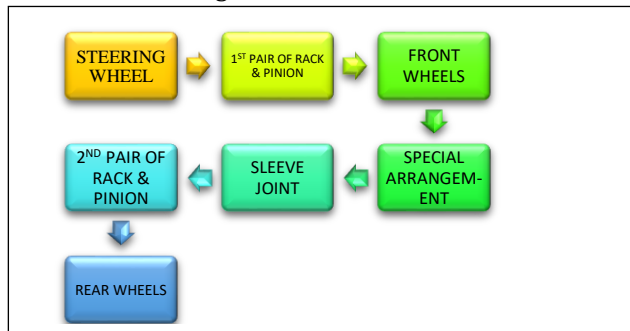
To increase its efficiency and for cost reduction in the existing systems, an optional four-wheel steering mechanism is been allotted which allows a driver to use it whenever needed.

Normally it will act as common front wheel steering used in most of the cars, but at times of sharp

turns, lane changing, speeding, driver can effectively and with a ease change it to four-wheel steering which helps it to perform these activities more safely and precisely. Moreover, it is a complete mechanical mechanism which contributes of spur gear in rack and pinion assembly, making it easy to manufacture and cost effective.

**4. CONSTRUCTION:**

The block diagram below that is drawn for the 4 wheel steering mechanism, shows the components of a steering system. The first component of the steering system is is steering wheel. It is connected to the front wheels through the steering shaft. Tie rod is a connection between the wheels and steering system. 1 st pair of rack and pinion is situated on the tie rod. The pinion is connected to the steering shaft. As steering wheel rotates, Pinion will roll along with the rack. The rack and Pinion arrangement attached with an intermediate shaft. That shaft is cut into the two parts but it is always in engaged position whether it is fully engaged or partially engaged. It is a special arrangement used to vary the length. The shaft is further connected to the sleeve joint. Sleeve joint has serrations on the inner side up to the certain distance. Sleeve joint is used to increase the length of the shaft. It is further connected to the 2nd pair of rack and pinion. As shaft transmits the torque, Pinion will rotate and rear wheels of the steering system will move in a left or right direction.



**BLOCK DIAGRAM:**

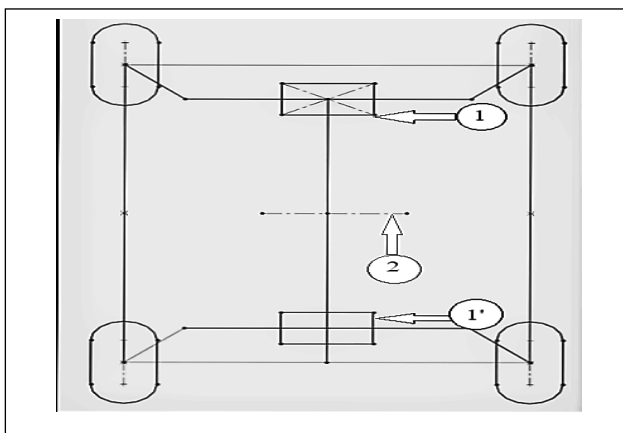


Fig 1: Line Diagram Of Four-Wheel Steering Mechanism line diagram,

In fig1 shows the position of the mechanical assemblies. Position 1(for front wheels) and 1' (for rear wheels) consist of rack and pinion assemblies each. Where the spur gear is used. Gear used is always in mesh with the rack. Where position 2 indicates special arrangement, which allows engaging in four-wheel steering mechanism

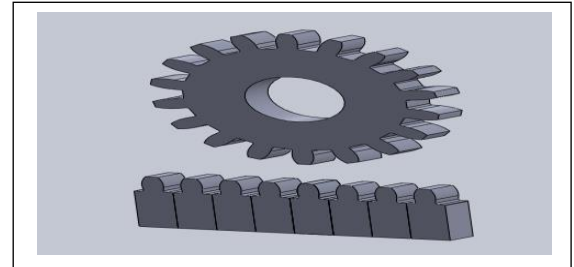


FIG 2: RACK AND PINION

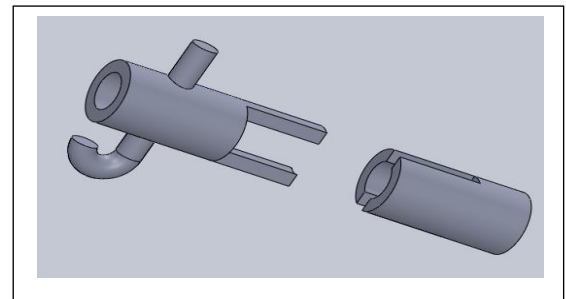


FIG 3: SPECIAL ARRANGEMET

Position 1 and 1'as in fig 2 comprises with rack and pinion, a rack and pinion is a type of linear actuator that comprises a pair of gears, (here spur gear) which converts rotational motion into linear motion

In above design spur gear is used as it have a high power transmission efficiency, which makes them ideal for preserving efficiency of the system. Manufacturing of spur gears is simple as compared to other gears and thus cost efficient, and serves the purpose.

These two assemblies are connected by an intermediate shaft. As shown in fig 1, position 2, a shaft is cut into two separate parts. Cut parts of the shaft have serrations on it, as in fig 4, up to the certain distance. There is a hole present in a shaft. A rod is placed in a hole.

With the help of the rod, engagement and disengagement of the rear side rack and pinion occurs.

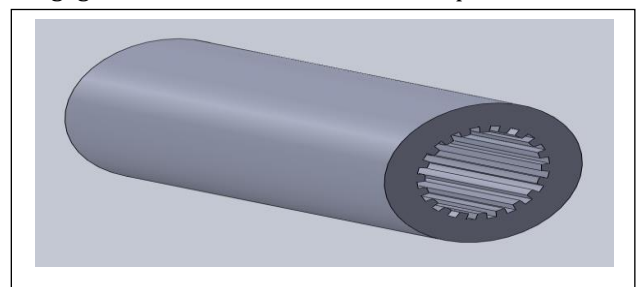


FIG 4: SERRATED ROD

## 5. OPERATION OF PROPOSED DESIGN:

### 1. Two-wheel steering mechanism:

Normally, it will steer front two-wheels as done in most of the vehicles. The steer rod will be connected to the arrangement of rack and pinion which will convert circular motion of steering wheel into linear motion and thus directs the front wheel, but as the shaft is not inserted inside the serrated rod, thus the motion is not transferred to the rack and pinion arrangement at position 1' which is further connected to rear wheels. Thus motion is only transferred to front wheels and hence only front wheels get steer.

### 2. Four-wheel steering mechanism:

In fig 1, at position 2, shaft is already engaged fully when the vehicle is steering on front two wheels. It is not connected to rack and pinion arrangement for rear wheels, fig1, and position 1'.

At the times, when driver wants his vehicle to steer on rear wheels too, rod as shown in fig 3, has to be pulled, which makes the two shaft partially engaged and engages its end to rack and pinion assembly for rear wheels, fig1, position 1'.

As a result speed is been transmitted and contact gets established, which in turn helps to steer rear wheels. Thus, this flexibility helps driver to drive smoothly.

## 6. CONCLUSION:

1. Complete mechanical system and use of spur gears, makes it cost effective and simple to manufacture.
2. As spur gears are used, makes it more reliable and durable.
3. As spur gear's power transmission efficiency is good, this makes it ideal for application.
4. System allows driver to take small and sharp turns quickly.
5. It increases maneuverability.
6. It neutralizes the steering and thus eliminates factor of over steer and under steer.
7. During high speed conditions, it helps to maintain stability of a vehicle.
8. This mechanism reduces steering efforts on front wheels, thus wearing of tyres is also reduced.
9. Simple construction of mechanism, makes system easy to install.
10. The rod provided in an intermediate shaft to engage in four-wheel steering system makes it user-friendly.

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