A Review of Altering Steering Ratio to Reduce Drivers Fatigue-Planetary Gear Approach

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***Abstract*— Steering is the set of components, linkages, The most convenient steering arrangement is to turn the front wheels using a hand steering wheel which is fixed in front of the driver, through the steering column, and it consist of various parts like universal joints, shafts etc., The steering system is composed of three major sub-systems, They are the steering column and wheel, the steering gear, and the steering linkage. As the steering wheel is turned by the operator, the steering gear transfers this motion to the steering linkage. The steering linkage turns the wheels to control the vehicle direction. The purpose of the steering wheel and column is to produce the force necessary to turn the steering gear.**

Keywords*— *Steering; column; sub-systems; vehicle direction; gear

I. INTRODUCTION

The steering mechanism is used to control the vehicle direction. The steering mechanism is developed to control the front axles over all type of road conditions and at different speeds with respect turning radius. It is made of a linkage system that is mate with one another to the front axles like the steering and the steering gear. Rack and pinion steering mechanism has stoppers on either side of the rack assembly.

II. LITERATURE REVIEW

A complete survey of the existing steering system of a four-wheeler was made. Currently there is no steering which has incorporated planetary gear sets. However planetary gear sets are used in ship steering mechanisms and vehicles automatic transmission gear boxes. Research papers related to the design of different types of planetary gear set (circular, non-circular), analytical expression for power transmission, ship steering system, were studied. Dr.S.R. Shankapal (2013) developed a four wheel steering system for a car. Production cars are designed to understand and rarely do they over steer. If a car could automatically compensate for a over steer problem the driver would enjoy nearly neutral steering under varying operations conditions. In situation like low speed cornering, vehicle parking and driving in city conditions with heavy traffic tight spaces. Driving would be very difficult due to vehicles larger wheel base and track width. Hence there is a requirement of a mechanism which results in less turning radius and it can be achieved by implementing four wheel steering mechanism instead of regular two wheel base. S.H.Yadav (2013) made an investigation of failure of planetary gear train due to pitting, planetary gear train is a gear system consisting of one or more planet gears, revolving about a sun gear. And it is widely used in industries. An epicyclical gearing system is particularly well suited for achieving a high reduction ratio in a relative small, power dense package. It is widely recognized that the load sharing is not equal among the planetary gear meshes. Similarly the stress distribution at each mesh point contains variability. Pitting is a surface fatigue failure of the gear tooth. It occurs due to misalignment; wrong viscosity selection of lubricant used, and contact stress exceeding the surface fatigue strength of the material. R.Masilamani (2015) made an experimental analysis of reducing steering ratio to reduce turning ratio, the concept has been developed to reduce the driver's effort during parking or maneuvering sharp curves. Using the additional planetary gear set with the existing steering gear box, steering ratio can be changed and hence the input speed to the steering wheel can be altered when to the steering gear box. On installing the planetary gear set and the modified rack and pinion steering gear box, the number of rotations made by the steering wheel for the given angle of road wheel rotation is altered. 6.Dr.Dinesh.N.Kamble has developed a concept based on the analysis of the transmission mechanism of angle superposition with active front steering system. A controller of variable steering ratio for AFS system is designed and virtual road tests are made in car. The results of simulation tests validate the controller performance and the advantage of the variable steering ratio function, also show that the driving comfort is improved at low speed especially due to the active front steering system alters the steering ratio according to the driving situation. P.A.Simionescu, llie Talpasanu (2006) synthesized the Ackermann linkage and steering control mechanism. And they concluded that it was required to maintain the steering error within acceptable values, so that the symmetric steering control is ensured for left and right of the vehicle. They used Nelder Mead simplex algorithm and AUTOCAD for their research.

8. Jose M.del Castillo (2001) in their research obtained the analytical expression for the efficiency of any planetary gear train using Cramer's rule. They find the gear tooth ratio

employing a speed and torque equations and gearing power and speed ratio.

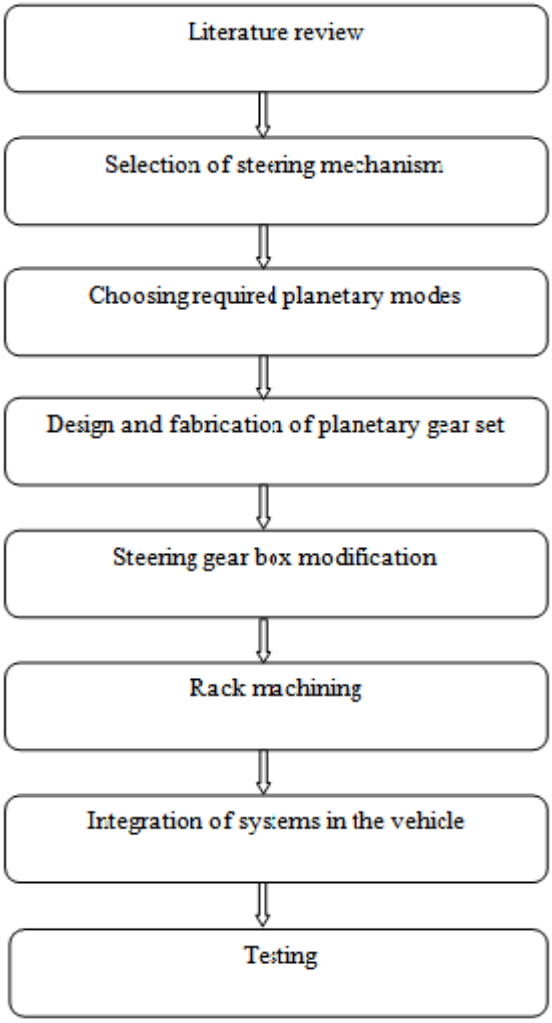
9. D.Mundo (2006) Designed a planetary gear trains to generate a variable angular velocity ratio using non- circular gears by using CAD software, PTC-pro engineer. He reduced the typical torque fluctuations of a low speed way of pedaling in order to maximize the output.

10. Daniele Vecchiato (2005) did a tooth contact analysis of an isostatic gear train for various cases. TCA proved to be a self-regulated system due to the existence of floating gears. Such a system is not sensitive to most errors of alignment.

III. METHODOLOGY

Objective of this project is to Design and analysis of steering mechanism using planetary gear for long vehicles to facilitate easy parking and maneuvering at the curves or it should reduce the driver's effort while negotiating a sharp curve. A planetary gear box is fabricated and need to install in a steering system. Existing rack and pinion gear box is modified so that it provides more steering angle. Planetary gear set doesn't consume engine power to facilitate overdrive. Steering ratio is altered in planetary gear set through simple mechanical linkages. Seeing wheel rotation is reduced massively when the planetary gear set is engaged in over drive. Driver's effort is very much reduced and this mode comes in handy especially when driver wants to turn the front wheels left and right from stopper to stopper very frequently.

- ✓ Literature survey of all the available journals on manual steering gearboxes and planetary gear sets gave an ideology on the proposed system. Based on that a feasibility analysis in made.
- ✓ As the steering column is going to have another gear box, it was essential to make a study whether it can be mounted.
- ✓ For achieving speed ratios in a planetary gear box, modes for operating between normal driving and parking conditions are selected.
- ✓ Size, module, number of teeth on each gear in planetary gear set are calculated for achieving the required gear ratios.
- ✓ Planetary gear set along with the actuating mechanism is fabricated and mounted on the steering column using suitable clamps and bolts.
- ✓ To facilitate turning wheels to turn more while parking, steering stoppers are machined out and extra rack teeth are machined on the tie rod.
- ✓ Rack teeth are machined on a milling machine using end mill cutter.
- ✓ While parking driver has to select over drive mode. So the wheels will turn more with less number of steering wheel rotations.
- ✓ While normal driving driver has to select direct drive mode. So the wheels will have a safe turning angle and driver will have a better road feel.



With this mechanism drivers effort is very much reduced especially while parking a vehicle on a narrow passage which normally requires more number of steering wheel rotations from stopper to stopper.

PROBLEM IDENTIFICATION:

Problems faced by conventional steering systems are:

- Parking and manoeuvring sharp curves is quite difficult as the driver has to make more steering wheel rotation to move from stopper to stopper. It increases fatigue.
- Angle turned by the steerable wheel is less and results in more turning radius. Long vehicle will have more turning radius and are difficult to park in a narrow passage.

Power assisted steering system also has some demerits

- Hydraulic pump of power steering have to be driven by engine. Hydraulic power steering requires oil to operate and it needs to be changed periodically along with the filter. System needs to be checked for leaks. It is larger and clunkier. Steering becomes even more difficult when the power steering fails.
- Electronic power steering cannot be used in huge vehicles. Circuit is complicated as ECU needs to take input from various sensors. It can't be repaired

without specialized diagnostic equipments and advanced tools. It is less reliable as it fails due to computer failure, computer damage or parts wearing out. Electronic power steering can kill the battery very quickly if the alternator fails. Costly when compared with traditional steering.

STEERING RATIO

$$\text{Gear ratio} = \frac{\text{No of teeth on the driver}}{\text{No of teeth on the driving g}}$$

A steering ratio is defined as the number of turns the steering wheel has to make for one turn of pit man arm. It is the ratio between the steering wheel angle and the corresponding angle in stub axle.

$$\text{Over all steering ratio} = \frac{\text{degrees through which steering wheel turns}}{\text{degrees through which front wheel turns}}$$

Steering gear ratio is determined by noting the number of turns required on the steering wheel to produce one turn of steering gear cross shaft.When the steering wheel is turned, a certain effort is needed. The amount of effort is determined by the mechanical advantage of the steering gear. The steering ratio is defined as the ratio between the degrees turned on the front wheels. The ratio is stated for exactly 1 degree movement on the front wheels. For example, a 30 to 1 steering ratio means the steering wheel will turn 30 degrees for each degree of front wheel turn. The lower the ratio, the harder the steering. The higher the ratio, the easier the steering. When the steering ratio increases, however, the steering wheel must be turned further to make a turn.

IV.RESULT AND DISCUSSION

The expected result and focus of this project is to design and analysis of a steering mechanism using planetary gear set to facilitate vehicle to be parked easily and it should reduce driver's effort while negotiating a sharp curve. A planetary gear box is fabricated and installed in a steering system. Existing rack and pinion gear box is modified so that it provides more steering angle. Planetary gear doesn't consume engine power to facilitate overdrive. Steering ratio is altered in planetary gear set through simple mechanical linkages. Seeing wheel rotation is reduced massively when the planetary gear set is engaged in over drive. Driver's effort is very much reduced and this mode comes in handy especially when driver wants to turn the front wheels left and right end very frequently.

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