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Vehicle Handling Improvement by Adaptive Steering System

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Abstract*— Vehicle handling improvement is used in modern vehicle to increase the efficiency of steering system. In adaptive steering system, the vehicle handlings improve the steering during the turning of wheel at low speed and slow movement of steering wheel. The basic future of this system is that there is no any steering shaft is required for transferring the mechanical power from steering wheel to steering gear box. An electronic device is used for transferring the steering singles from steering wheel to LCD and then steering signals transfer from LCD to a servo motor. A servo motor which is connected from LCD is used to give the movement to a set of rack and pinion and finally rack and pinion connected from final drive to drives the wheels. So now finally conclude that the adaptive steering system are used to transferring the power from steering wheel to final drive without steering shaft. It is helpful for modern vehicle and increases the efficiency of steering wheel and also reduces the weight and cost of steering system.

***Index Terms*—Adaptive, improvement, transferring, rack, pinion, etc.**

I. INTRODUCTION

The maximum conventional steering systems are operates the steering wheels through hand and turn the steering wheel from steering shaft to steering gear box and to drive the front wheels of vehicle. It contains the universal joint to sustain the angular displacement of steering shaft. The steering columns are fitted to the end of a column. When the steering wheel is operated, the knuckle moves to and fro and to moves the wheels right or left. For car manufacturer and users the adaptive steering systems are more useful for enhancement of steering function. Adaptive steering systems which are coupled from power steering are more useful for steering system, manufacturer and users. Development and production of electronic steering system are purely adaptive steering system which creates high efficiency and high safety for modern vehicles. Adaptive steering system adjust the steering ratio and to adapt the changing condition of vehicle as per the speed of vehicle. At low speed the system turns the front wheels as a greater distance for the same amount of movement of wheel. When the vehicle running at high speed the vehicle turn as traditional steering system and driver achieve the rotation of wheels as in a control way. When the steering ratio is gradually decreases the less turning of steering wheel is required. Adaptive steering system in automobile required steering wheel, gear box, LCD, linkages and other components are required for steering system. During the parking of vehicles, the friction between the front tire and road is increases and more effort is required. To reduce the effort of steering, the wheel is connected to a gear box which reduces the effort and increases the turning efficiency of steering wheels.

II. COMPONENTS USED FOR ADAPTIVE STEERING SYSTEM

- Steering
- Servo Motor
- Rack & Pinion
- Microcontroller
- LCD
- Potentiometer
- Universal Joint
- Control Circuit
- Shaft
- Battery

III. METHODOLOGY

While power steering has made it possible to drive around without giving by an exhausting upper body workout, the steering ratio of most vehicles that is, the number of turns of the steering wheel required to turn the front wheels a certain amount is fixed. As the name suggests, adaptive steering system adjust the steering ratio of a vehicle to adapt to changing conditions. The basic future of this system is that there is no any steering shaft is required for transferring the mechanical power from steering wheel to steering gear box. In this case, the speed of the vehicle at low speeds, the system turns the front wheels a greater distance for the same amount of rotation of the steering wheel. An electronic device is used for transferring the steering singles from steering wheel to LCD and then steering signals transfer from LCD to a servo motor and then final drive. When travelling at highway speeds, the system doesn't go in the other direction and make it so the driver needs to turn the steering wheel further to achieve the same result as traditional steering systems. Rather the steering ratio is gradually reduced the faster the vehicle goes, so that less turning of the steering wheel is still required, but as speed increases its effects will be less and less noticeable compared to traditional steering. In the adaptive steering system the missing direct mechanical link between steering wheel and steered wheels. With such a steer-by-wire steering system the missing steering column's function must be reproduced in both directions of action. In forward direction the angle set by the driver at the steering wheel is measured by a steering angle sensor and transferred with the suitable steering ratio to the wheels. In reverse direction the steering torque occurring at the wheels is picked up via a

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torque sensor and attenuated respectively, modified fed back to the driver as a counter torque on the steering wheel.

Technology Functionality-In prior systems the driver's steering inputs were communicated mechanically. Now the Direct Adaptive Steering utilizes electronic signals and can transmit the driver's steer inputs faster than a mechanical system. At the same time, the system communicates information from the road surface to the driver in a way that is faster and easier to understand. The system communicates the driver's steering inputs to the Electronic Control Unit (ECU).

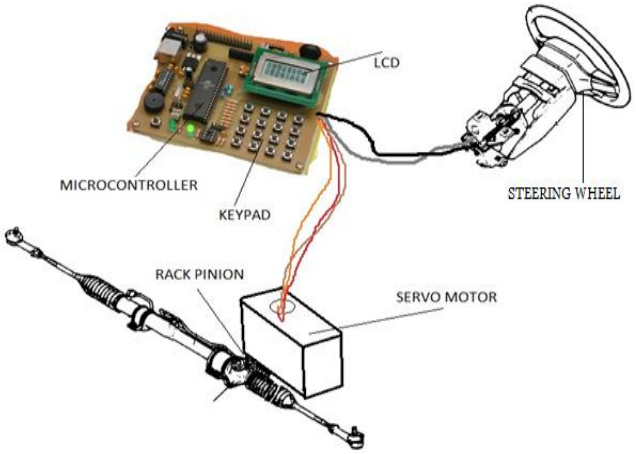

Fig-1 Adaptive Steering Mechanism (Steer by Wire)

The ECU then converts the information to control signals for the steering angle actuator, adjusting the cutting angle of the front tires. The road information, such as the force on the tires, is simultaneously communicated from the steering angle actuator to the ECU, which then screens it and returns only the information necessary for driving back to the steering wheel. Another major function of the direct adaptive steering is the newly developed straight-line stability system. If the vehicle's line of travel deviates from a straight path, the direct adaptive steering enhances the car's handling characteristics by producing fractional sensations of resistance as feedback from the steering, helping the driver keep a straight line of travel and reducing the need for course corrections in a smooth and natural way.

Technology Configuration-Direct Adaptive Steering uses multiple ECUs to simultaneously monitor the vehicle's operating condition. The beauty of the system is that the additional parts a DC electric motor, a worm gear driving a helical gear at a 48:1 reduction ratio, two needle bearings, and an electronic control circuit are housed totally within the steering wheel. The Adaptive Steering components add only one kg to five kg steering-wheel assembly. Responding to commands from a control circuit that monitors vehicle speed and steering-wheel position, the electric motor adds or subtracts up to 35 percent to the motion the driver imparts to the steering wheel. At low speeds and high turn angles say, during a parking maneuver or when slaloming through traffic cones at a construction site the helper motor adds steering lock so the driver's arms and elbows are less of a blur. Then at cruising speeds, steering response is diminished so lane changes are more fluid and napping passengers never bang heads.

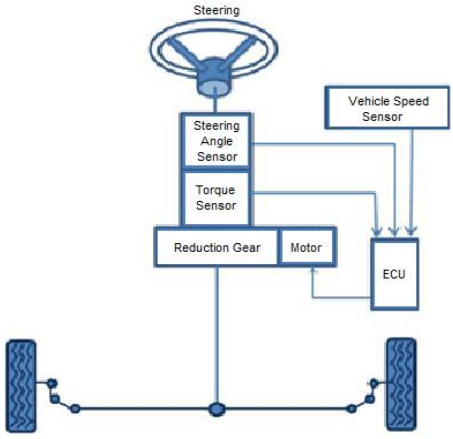

Fig-2 Electrical Steering Mechanism

This improves fuel economy while also eliminating the weight and bulk of the power steering pump and hoses. By monitoring the driver's steering inputs, vehicle speed, and other suspension dynamics, the system can provide just the right amount of steering feel and effort to match rapidly changing driving conditions. EPS can deliver extra effort when we need it, and reduce steering effort when we do not need it. It can even provide steering assist when the engine is off.

IV. CALCULATION

When the vehicle is moving very slowly, there is a kinematic condition between the inner and outer wheels that allows them to turn slip-free. The condition is called the Ackerman condition and is expressed by-

$$\mathrm{Cot}\delta_0 - \mathrm{Cot}\delta_i = w/l$$

where, δ_i is the steer angle of the inner wheel,

δ_o is the steer angle of the outer wheel and

w is the front track

l is the wheelbase of the vehicle

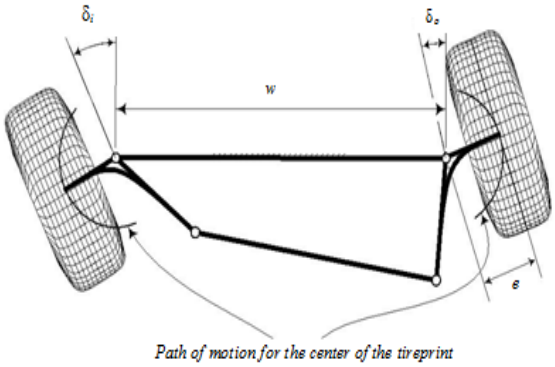

Fig-3 Ackerman Condition of Wheels

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The mass center of a steered vehicle will turn on a circle with radius R. To find the vehicle's turning radius R, we define an equivalent bicycle. Then

$$R = \sqrt{a_2^2 + l^2 \cot\delta^2}$$

Where, a is the lengths of the links of a four-bar linkage and

δ is the cot-average of the inner and outer steer angle that is-

$$\cot\delta = \frac{\cot\delta_o + \cot\delta_i}{2}$$

The Ackerman condition is needed when the speed of the vehicle is too small, and slip angles are zero. There is no lateral force and no centrifugal force to balance each other.

The outer point of the front of the vehicle will run on the maximum radius R_{Max}, whereas a point on the inner side of the vehicle at the location of the rear axle will run on the minimum radius R_{min}. The front outer point has an overhang distance g from the front axle. The maximum radius R_{Max} is

$$R_{Max} = \sqrt{(R_{min} + w)^2 + (l + g)^2}$$

V. RESULT AND DISCUSSION

1. Adaptive steering system saves fuel because it does not siphon off engine power as traditional hydraulic steering.
2. Adaptive steering system reduces the steering rod including universal joint. So it also reduces the cost and reduces the weight of vehicle.
3. In adaptive steering system, there is no any hydraulic power system is required for steering of wheels. So this system save the power and reduce the cost of hydraulic steering system.
4. Adaptive steering responds more quickly and accurately to the software running, such modern system will use as parking assist and lane-changing assist.
5. In hydraulic steering a belt from the engine, drives a pump continually to maintain the hydraulic pressure. But in adaptive steering system there is no hydraulic steering is required. So the adaptive steering systems minimize the overall cost of steering mechanism.
6. In future, the software used in adaptive steering will be used into the robotized steering which are the automated steering and will be the feature of autonomously driven cars.

VI. CONCLUSION

1. Future innovative steering functions, such as vehicle dynamic interventions, collision avoidance, individual wheel steering, tracking assistance, automatic lateral guidance, and finally autonomous driving functions will be implemented in a system compound of various vehicle systems.
2. The steer by wire system or adaptive steering principle becomes absolutely necessary when those innovative functions are to be achieved.
3. The transition to purely electrical steering systems will proceed step by step, both for safety reasons and acceptance by the customer.
4. This paper presents various types of electrical steering systems and their safety aspects. The electro hydraulic power steering does no longer operate the hydraulic pump via a V-belt drive from the internal combustion engine. Rather, an electric motor is used, yielding energy savings and flexibility of installation. Electrical power steering pursues this trend and offers additional advantages since no hydraulic system is required.
5. A steer by wire system with hydraulic backup and a purely electrical system were discussed.
6. Future steering systems will thus have to be integrated into a system compound, in terms of interfaces and functions.
7. The path will lead from electrical power steering via a steer by wire system with a hydraulic or mechanical backup towards purely electrical steer by wire system.

COMPARISON TABLE BETWEEN ADAPTIVE STEERING AND MECHANICAL STEERING

sl	Adaptive Steering	Mechanical Steering
1.	Adaptive steering is a system that helps in steering the wheels using some source of power.	Mechanical steering is a system in which mechanical force is used for steering.
2.	The response is comparatively quick.	The response is comparatively slow.
3.	Resistance to wheel movement is less.	Resistance to wheel movement is more
4.	It is preferred for comparatively heavy weight vehicles.	It is preferred for low weight vehicles.
5.	A hydraulic pump, fluid reservoir, hoses, lines; and either a power assist unit mounted on integral with, a power steering gear assembly.	Steering wheel and column, a mechanical gearbox and pitman arm or a rack and pinion assembly, linkages; steering knuckles and ball joints, and the wheel spindle assemblies are mounted.
6.	It absorbs road shocks, minimum efforts, greater safety and controllability under critical situations.	Mechanical connection between the steering wheel and the wheel and all the components continues to be maintained without the help of the auxiliary power.

VII. FUTURE SCOPE

1. These systems would completely eliminate the mechanical connection between the steering wheel and the steering, replacing it with a purely electronic control

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system.

2. It would contain sensors that tell the car what the driver is doing with the wheel, and have some motors in it to provide the driver with feedback on what the car is doing.
3. Since the power steering pump on most cars today runs constantly, pumping fluid all the time, it wastes horsepower. This wasted power translates into useful fuel. We can expect to see several innovations that will improve fuel economy. One of the coolest ideas on the drawing board is the steer by wire or drive by wire system.
4. It would also reduce vibration inside the car. General Motors has introduced a concept car, the Hy-wire that features this type of driving system.
5. Essentially, the steering wheel would work like the one we can buy for our home computer to play games.
6. The output of these sensors would be used to control a motorized steering system. This would free up space in the engine compartment by eliminating the steering shaft.
7. In future drive by wire vehicles, we will most likely be able to configure the controls exactly to our liking by pressing a few buttons, just like we might adjust the seat position in a car today.
8. One of the most exciting things about the drive by wire system in the GM Hy-wire is that we can fine tune vehicle handling without changing anything in the car's mechanical components all it takes to adjust the steering is some new computer software.
9. It would also be possible in this sort of system to store distinct control preferences for each driver in the family. In the past fifty years, car steering systems haven't changed much. But in the next decade, we'll see advances in car steering that will result in more efficient cars and a more comfortable ride.

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