4-WHEEL STEERING SYSTEM MECHANISM USING DPDT SWITCH

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ABSTRACT

In standard 2 Wheel Steering System, the rear set of wheels are always directed forward and do not play an active role in controlling the steering, thus it results in increased turning radius. While in 4 Wheel Steering System, the rear wheels do play an active role for steering and helps to decrease the turning radius. Vehicle parking and driving in city conditions with heavy traffic in tight spaces, driving would be very difficult due to larger wheelbase and track width. Hence there is a need of a mechanism that can decrease the vehicle’s turning radius. We have developed an innovative 4 wheel steering design to implement a mechanism that can be used for high speed lane changing, crab steer, parallel parking depending upon the conditions of turning and lane changing with respect to front wheels, by using servo motors and direct current motor which are controlled by DPDT switch, thus enhancing the maneuverability of a sedan.

Key words: 4-Wheel steering, DPDT Switch, Turning radius, Lane changing, Crab steer, Parallel parking, Servo motors, DC motors


1. INTRODUCTION

With the increase in demands for an automobile, parking problems are increasing proportionally. Now-a-days people are willing to buy bigger vehicles, which are more powerful, which requires more parking space, causes severe parking problems at home, office, multiplexes etc.

Four wheel steering vehicle can be employed to increase the maneuverability, easy parking and smooth lane changing. Mostly available four wheel steering vehicle uses guiding computers and electronics for steering control, our concept uses mechanical in combination with electronics to steer the vehicle in different direction.
This paper focuses on feasibility and innovative approach which uses 4 rack, 2 pinion arrangement enclosed in a casing. There will be 4 direct current motors for propulsion and minimum turning radius and 2 servo motors for other operating modes. Driving modes can be change by a press of a button. We have used DPDT (dual pole dual throw switch) to change the polarity of the motor which tends to change the direction of the rotation. Since there are independent motors for each pinion, there is no need of motion transmission from front to rear which in turn reduces the total weight.

2. LITERATURE REVIEW
2.1. Perfect steering condition
While negotiating a turn, the condition is said to be true rolling or perfect steering when the axes of the all 4 wheels should meet at a point known as instantaneous centre and when the following equation is satisfied.

\[ \cot \varphi - \cot \theta = c/b \]

2.2. Parallel parking
Zero steer can significantly reduce the parking problems that driver has to deal with in metro cities. In foreign countries parallel parking is preferred which includes driver’s skills as well as more space for parking. In parallel parking the car has to be parked between 2 vehicles, such maneuver requires 3 way motion of the vehicle, hence increases steering inputs. Additionally vehicle requires 1.75 times length of the car to successfully park the vehicle without damage.

As it can be seen, with the zero steer car requires about the same length, as its own for the parking. Moreover in the 360° rotation the driver does not need to steer the vehicle, all he has to do is braking and throttling to park the vehicle.
2.3. The DPDT (Double Pole Double Throw) switch
A Double Pole Double Throw (DPDT) switch is a switch that has 2 inputs and 4 outputs; each input has 2 corresponding outputs that it can connect to. Each of the terminals of a double pole double switch can either be in 1 of 2 positions. This makes the double pole double switch a very versatile switch. With 2 inputs, it can connect to 4 different outputs or reroute a circuit into 4 different modes of operation.

3. THE CONCEPT
This concept has 4 rack and 2 pinions, one pinion at the front and other at the rear. Pinion is connected by a geared servo motor which is operated through the 12V battery and the direction of rotation can be change by changing the polarity of the motor, which is done by the DPDT switch. There are 4 bell crank lever for parallel parking, which helps to rotate the wheels through 90°. In this concept there are 4 modes of operations which are as follows.

3.1. Crab steer
In crab steer all of the wheels will rotate in same direction, with the same angle.
3.2. Co-ordinated steer
In coordinated steer, wheels at the front will rotate in opposite direction, to the wheels at the rear.

3.3. Minimum turning radius
For minimum turning radius, wheels of one side of the vehicle will rotate in opposite direction, to the wheels of another side of the vehicle.

3.4. Parallel parking
In this condition axis of wheels will be perpendicular to the axis of the tie rod.

4. CONSTRUCTION OF THE MECHANISM

1. Pinion is connected to the servo motor with the help of gear which is mounted on the servo motor.
2. The gear of rack is connected to the pinion gear for converting the rotational motion of the servo motor in to the translation motion.
3. There are 3 pivot at the bell crank lever, first is connected with the rack, second is connected to the chassis, while the third one is connected to the hub.
4. There are 2 DPDT switches for the front and rear respectively.
5. Each DPDT switch is connected to one motor, total two.
6. For the propulsion and for minimum turning radius of the vehicle DC motors are employed at each wheel.

7. There will be another set of DPDT switches for changing the polarity of the DC motor.

8. Two DPDT switches are connected to 4 DC motor for minimum turning radius.

9. Two of the DC motors will be in series with each other, while other two will be in series connection with each other, hence with one switch, two motors can be operated simultaneously.

5. DPDT SWITCH FOR CHANGING THE POLARITY OF MOTOR

5.1. When switch is not shorted

In an initial condition when the switch is in off state, than the terminal C and terminal D are not connected to any of the terminal, which doesn’t allow any current to flow in to the circuit, since the circuit is not completed. This will stop the motor from rotating.

5.2. For clockwise rotation of the motor

Working for clockwise rotation of the vehicle is shown in the figure. When the terminal C is connected to the terminal A, and also, terminal D is connected to the terminal B then the motor will rotate in clockwise direction. The direction of current flow is, positive terminal of battery -D-B-E- positive terminal of motor-negative terminal of motor -F-A-C- negative terminal of battery. In this way the motor will rotate in the clockwise direction.
5.3. **Condition 3. For anticlockwise rotation of the motor**

Working for the anticlockwise rotation of the motor is shown in Figure. When the terminal C is shorted with terminal E and terminal D is shorted with terminal F than the direction of current is from positive terminal of the battery - terminal D - terminal F - positive of the motor - negative of the motor - terminal E - terminal C - negative of the battery. As can be seen that the polarity of the motor has changed due to change in the direction of current.

6. **WORKING FOR DIFFERENT MODES**

6.1. **Crab steer**

For crab steer, the motor at the front wheels will rotate in the same direction as motor at the rear wheels. This will turn the wheels at the front of the vehicle in same direction as of the wheels at the rear of the vehicle.

6.2. **Coordinated steer**

For coordinated steer, the motor at the front wheels will rotate in the opposite direction to the motor at the rear of the vehicle. This will turn the wheels at the front in opposite direction, to the wheels at the rear of the vehicle.

6.3. **Parallel parking**

With the help of the bell crank lever, all the wheels can be turned through 90°.
6.4. Minimum turning radius
Minimum turning radius can be obtained through the opposite rotation of the wheels of right side of the vehicle to the wheels of left side of the vehicle or vice versa, depending upon the side of rotation of the vehicle.

7. ADVANTAGES
1. The vehicle’s cornering behavior becomes more stable and controllable at high speeds as well as on wet or slippery road surfaces.
2. There are no mechanical linkages for the connection between front wheels and the rear wheels, hence weight reduction.
3. Decrease in turning radius of the vehicle.
4. DPDT is a cost efficient device, hence decrease in overall cost of the system.

8. CONCLUSION
As per the focus of the project we have created an innovative 4 wheel active steering mechanism using DPDT switch which is feasible to manufacture, easy to install and highly efficient in crab steer and coordinated steering. This system assists in high speed lane changing and better cornering. It combats the problems faced in sharp turning. It reduces the turning circle radius of the car and gives better maneuverability and control while driving at high speeds, thus attaining neutral steering.

Moreover components used in this system are easy to manufacture, material used is feasible, reliable and easily available in market. The system assembly is easy to install and light in weight and can be implemented in all sections of cars efficiently.

REFERENCES