

# Development of 360° Rotating Vehicle

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## Abstract

The aim of this paper is to develop a zero turning vehicle. Instead of operating by gear system, we are using pneumatic system for operation of this vehicle. Replacing two wheel drive by four wheel drive makes more convenient for the vehicle to take the turn. Conventional steering involve either the Ackerman or Davis steering system which has major disadvantage that it can't take minimum radius turn. We try to solve the problem of turning radius by new concept of zero turning vehicle with mechanical linkages and pneumatic cylinders. The main purpose of this project is to reduce the turning radius and turning space by rotating at same place without leaving its centre of gravity. In this system, the wheels connected to the front axles are turned opposite to each other, and so are the wheels connected to the rear axle. The wheels on the on left half vehicle rotate in one direction and the ones on the right half of the vehicle. To overcome problem like vehicle maneuvering on narrow roads and during parking this system has been proposed.

**Keywords: Turning Radius, Zero Turning Mechanism, Four Wheel Steering, 360° Rotation**

## I. INTRODUCTION

In present world, automobile has become essential for transportation of goods and passengers. By Benz in the year 1893, the first four wheel automobile was introduced. Four wheel steering is a method developed in automobile industry for the effective turning of the vehicle and to increase the maneuverability. In a typical front wheel steering system the rear wheels do not turn in the direction of the curve and thus curb on the efficiency of the steering. In four wheels steering the rear wheels turn with the front wheels thus increasing the efficiency of the vehicle. The direction of steering the rear wheels relative to the front wheels depends on the operating conditions. At low speed wheel movement is pronounced, so that rear wheels are steered in the opposite direction to that of front wheels. At high speed, when steering adjustments are subtle, the front wheels and the rear wheels turn in the same direction. By changing the direction of the rear wheels there is reduction in turning radius of the vehicle which is efficient in parking, low speed cornering and high speed lane change.

In many or all vehicles are steered by turning the front wheels in desired direction, while rear wheels following there are several problems of parking at public places, parking at home, parking at multiplexes and traffic jam etc. So, to overcome this problems main aim is to developing the system having minimum turning radius or required minimum turning space. so we have choose zero turn vehicle as the name itself indicates the meaning that a vehicle take the turn with zero turning radius and gives circular and gives circular path without leaving its vertical axis through the center.

### A. What is Steering?

The various functions of the steering wheel are, to control the angular motion the wheels; direction of motion of the vehicle, to provide directional stability of the vehicle while going straight ahead, to facilitate straight ahead condition of the vehicle after completing a turn, the road irregularities must be damped to the maximum possible extent. This should co-exist with the road feel for the driver so that he can feel the road condition without experiencing the effects of moving over it.

Steering is the term applied to the collection of linkages, components etc. which will allow a vehicle to follow the desire path. The most conventional system is two wheel steering system.

The purpose of steering is to ensure that the wheels are pointing in the required directions. This is typically achieved by a series of linkages, rods, pivots and gears. One of the basic principle is that of caster angle - each wheel is steered with a pivot point ahead of the wheel; this makes the steering tend to be self-centering in desired direction of travel. We have to consider the fact that in a turn, the inner wheel is actually travelling a path of smaller radius than the outer wheel, due to which the degree of toe appropriate for driving in a straight path is not suitable for turns. Another thing influence the steering dynamics is angle made by wheels with vertical plane.

Modern cars mostly use rack and pinion steering mechanisms, in which steering wheel turns the pinion gear; the pinion moves the rack, which is a linear gear that meshes with the pinion, this mechanism converting circular motion into linear motion along with transverse axis of the car. The steering torque is applied by this motion to the swivel pin ball joints which replaces kingpins used previously of the stub axle of the steered wheels via tie rods and a short lever arm known as the steering arm.

## II. STEERING WHEEL CONFIGURATIONS

The various types of steering wheel configuration are as follows

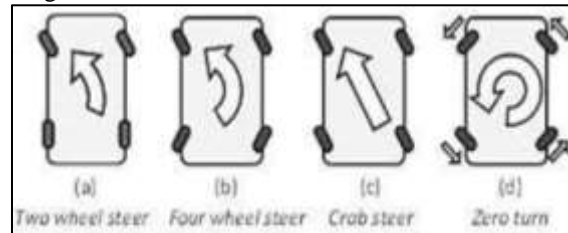


Fig. 1: Steering Wheel Configuration

- 1) Two Wheel Steer: In this mode only one axle is driven.
- 2) Four Wheel steer: In this both axle are driven but in direction opposite to each other.
- 3) Crab steer: When all the wheels turn in same direction it is known as crab steer.
- 4) Zero turn steer: In this mode vehicle follows the circular path.

## III. LITERATURE REVIEW

According to the “Study of 4 Wheel Steering Systems to Reduce Turning Radius and Increase Stability” research papers<sup>1</sup>. In these paper they have explained the steering system. They also explain the different types of steering system. The basic aim of steering is to ensure that the wheels are pointing in the desired directions. This is typically achieved by a series of linkages, rods, pivots and gears. One of the fundamental concepts is that of caster angle - each wheel is steered with a pivot point ahead of the wheel. In the paper they also explain the different types of steering system like 2 wheels, 4 Wheel Steering Systems, crab system etc. From these we found crab system more useful for the development of our project. Crab steering is a special type of active four-wheel steering. It operates by steering all wheels in the same direction and at the same angle. Crab steering is used when the vehicle needs to proceed in a straight line but under an angle.<sup>[1]</sup>

According to the jaishnumoudgil and Mudit chopra they explain the problem of parking the car that as per the modern development and economical progression of Indian society resulted in increase of cars on roads. Due to space constraints, car parking is the major problem faced in most parts of the country. Present study aims for development of a system to reduce the turning radius of a car. Based on these problems the development of 360 rotating vehicle is more important so that it will take less time and less space for parking.

In their project they had used kinematics links, gearing system for performing the zero turn of the car which would more help to overcome the problem but the main drawback for that the backlash of the gear. Apart from that the zero turn vehicle also use less fuel less time as compared to normal vehicle.<sup>[2]</sup>

In the next paper of “Zero Turning of four wheel steering system.” they explain the type of steering system, uses of dc motors with switch board. With the help of switch board they control the direction of the wheels. There zero turn four wheel steering vehicle will move on power supply from an A.C. source. The switch board is a combination of two ways switches and ON/OFF switch. Now to give the constrained motion i.e. forward and reverse motion, we are using a set of two on and off switch and two 2 way switches.<sup>[3]</sup>

## IV. PROBLEM DEFINITION

The above picture is the common scenario which everyone of us often get to see in our day to day life. According to the survey done by park at any house in U.S people driving the car wastes nearly 10256 hours i.e approximately 106 days of their life of their life in parking the car also it was found that 5% of more fuel is consumed during parking. This was the survey done in US if it would have been done in India then these no will definitely increase. Mostly in villages where there is only one way road if we reach our destination and want to return back we need to go far ahead in search of sufficient space where our vehicle gets turned

this consumes more time and fuel also while it becomes an obstacles for the running cars on the road which reduces their momentum of speed. So we are designing a 360° rotating vehicle which rotates on its position without much fuel and time consumption also it does not becomes a hurdles for the cars running on the road.



Fig. 2: Parking Problem

## V. OBJECTIVES

- 1) Designing prototype system.
- 2) Reduction in turning time.
- 3) Overcome parking problem
- 4) To rotate the vehicle without leaving its centre of gravity

## VI. METHODOLOGY

### A. Working Principle

The 360 degree rotating vehicle is based on the principle by using pneumatic system in which compressed air is used to tilt the wheel where the vehicle will take a zero turn without leaving its C.G axis. The wheels will drive the vehicle to rotate 360 degree. The 360 degree vehicle consist of three pneumatic cylinder, one 5/2 direction control valve, Dc motor, mechanical linkages and pipes through which compressed air is passed. The air is pressurized in the compressor. The system works when the compressor starts the pressurized air is passed to the 5/2 direction control valve through pipes. The 5/2 direction control valve is operated manually when the direction valve is open the compressed air pass through pipes to pneumatic cylinder. The direction control valve is used to control the path of pressurized air. The pressurized air which is supplied to the cylinder will move the piston in reciprocating motion. The piston cylinder is called as actuator. The piston cylinder then actuates and moves outwards. The linkage which is connected to piston and wheels will push the wheel outward giving them the required motion. In the mean while the dc motor which is connected to the front of the right wheel and to the of the left rear wheel both will rotate opposite to each other if one will rotate in clock wise other will rotate in anti-clockwise the switching of motor is controlled manually giving the vehicle zero turn. The 360 degree rotating vehicle is the name itself giving the meaning that a vehicle take the sharp turn with zero turning radius and follow exact circular path without leaving its vertical axis passing through the centre. As shown in the fig no.3 when the direction control valve is closed it takes it normal position as the pressurized air does not pass to the pneumatic cylinder and the piston cylinder is at it normal position and wheels does not tilt.

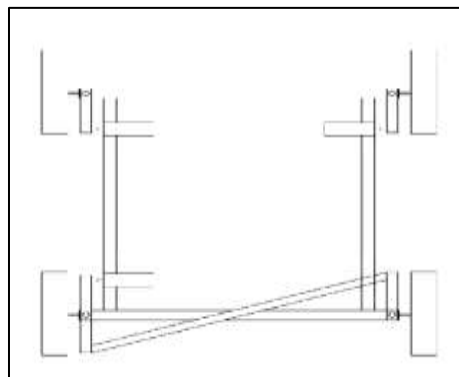


Fig. 3: Before actuating

As the direction control valve is switched open the pressurized air is then passes to the pneumatic piston and piston is then actuated and through linkages it tilts the wheels in 45 degree as shown in fig no.4

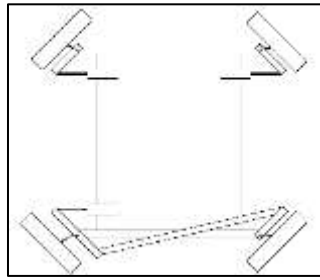


Fig. 4: After actuating

## VII. CONSTRUCTION

### A. Basic Components

#### 1) Basic Frame

The hollow square pipes of material of mild steel are selected for the frame. The pipes are cut into required size by cutting machine. The end of the pipes cut into 45 degree to form rectangular frame. After cutting, the end of the square pipes is grinded so that it became smooth and convenient for welding. The square pipes are welded together to form a rectangular basic frame.

#### 2) DC Motor

Electric motor is machine which convert electric energy into mechanical energy. Its action is based on the principle that, when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's Left Hand Rule.

#### 3) Pneumatic Cylinders

In pneumatic cylinder power of compressed gas is used to produce reciprocating linear motion.. Because, the operating fluid is a gas, leakage from the pneumatic cylinder will not drip out and contaminate the surrounding. So it is desirable where cleanliness is required.

#### 4) Direction Control Valve

Direction control valve are used for distribution of energy to various actuators by controlling the direction of flow of the pressurized oil or gas in the system. Generally DCV controls the fluid flow

#### 5) Hoses

Hoses are made completely flexible to carry high pressure compressed air. It can withstand high temperature and pressure gases.

#### 6) Adapter

Adapter is used to convert AC current supply to DC current supply. It can be very useful for thermal protection, overload protection etc. it can also protect from short circuit.

#### 7) Wheels

Wheels are the end link of the vehicle which give direct output of the system. They are move on a ground having rubber coating to outer side of the wheel for gripping. It carries whole weight of the vehicle.

#### 8) Links

A link is a rigid body which has two nodes which are used to attach other links. Linkages are the basic for all mechanisms. Linkages are made up of links and joints. Types of links depending upon nodes

## VIII. CONCLUSION

Different mechanisms were adopted by trial and error method, in order to facilitate the engagement of the wheels in the required direction, and the most convenient method was adopted. The time analysis, for the time required to perform a parallel parking maneuver and a 360° turn was carried out, and it led to decrease in the time required for the performance of the above operations. The prototype was tested to ensure the conformity with Ackermann's steering condition, and it complied with the same.

- 1) Time required for turning is less as compared to conventional steering system.
- 2) Space required for turning is less.

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