

## **STUDY OF ZERO TURN VEHICLE**

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### **ABSTRACT**

*The aim of this paper is to develop an alternative solution for conventional two wheel steering system .In modern era, the major characteristics of the vehicle like steer ability and handling have become major aspects. Conventional steering involve either the Ackerman or Davis steering system which has major disadvantage is it can't take minimum radius turn. Providing zero turn steering without any compromise in steer ability and handling of the vehicle is a major concern for automakers. The main intention is to improve the zero turn steer ability of the vehicle without wheel wandering problems. The number of vehicles are continuously increasing It causes the problem of traffic congestion, pollution (noise and air). To overcome problem like vehicle maneuvering on narrow roads and during parking this system has been proposed. Zero turn steering gives much better maneuverability and control on the car. We have developed an innovative idea about four wheel steering design to implement a mechanism that can take minimum radius turn about its gravitational axis. Zero turning is done by turning drive wheels at the same rate in opposite direction. By steering the rear wheels in the direction opposite the front wheels at low speeds, the vehicles turning circle radius is greatly reduced. Zero turn vehicle system is used in jeep hurricane. In that the wheel positioning system was directly connected to the steering system, due to that reason steering system was more complicated .This problem can be solved using new concept of zero turn vehicle by using a pneumatic operating system. This is achieve by using a compressor. In this system wheels are tilt in required position and then turned in the required direction. The mechanism was found sufficiently capable in turning the car in any direction without steering and has turning radius equal to the length of car itself.*

*The project deals with having a separate pneumatic system to driving the four wheel. If one wheel is turning in forward direction then other will rotate in opposite direction.*

*As the vehicle is rotate in 360 degree therefore it is very useful to turn the vehicle in narrow space. Hence, this project is very useful in our day today's life. This system can be useful to solve the parking problems in at public places, malls, multiplexes, better parking, traffic jam, back turning on narrow roads, etc.*

**Keywords: Turning Radius, Zero Turn Mechanism, Steering Wheel Configuration, Four Wheel Steering mechanism, parallel parking.**

### **I. INTRODUCTION**

Zero turn vehicle as the name itself indicates the meaning that a vehicle take the turn with zero turning radius and gives circular path without leaving its vertical axis passing through the center.

Zero degree turning radius vehicle implies the vehicle rotating about an axis passing through the center of gravity of vehicle i.e. the vehicle turning at the same place, where it is standing. No extra space is required to turn the vehicle. So vehicle can be turned in the space equal to the length of the vehicle itself.

Today most of the vehicles use the two wheel steering system as their main steering system. The two wheel steering system has the low efficiency as compared to four wheel steering system. The four wheel steering system can be employed in some vehicles to increase their steering response, increase vehicle stability when moving at certain speed, or to decrease turning radius at low speed. Four-wheel steering is a technically, marvelous effort on the part of automotive design engineers to provide near-neutral steering. In situations like vehicle parking, low speed turning and driving in city conditions with heavy traffic in tight spaces, high speed lane changing would be very problematic because of vehicle's larger wheelbase and track width. It gives high inertia and traction into consideration. Therefore there is need of a mechanism which result in less turning radius. This can be achieved by using four wheel steering system instead of conventional steering.

## 1.1 Steering System

Steering mechanism is used to give the required path and achieve a perfect steering condition. The main function of the steering system is to achieve angular motion of the front wheels to negotiate a turn. For steering linkages and steering gear used which convert the rotary motion of steering wheel into angular motion of the front road wheels.

## 1.2 Functions Of The Steering System

1. To control direction of motion of the vehicle
2. To give directional stability for vehicle while going straight ahead.
3. To enables straight ahead condition of the vehicle after completing a turn.
4. The road irregularities must be damped to the maximum possible extent. This should co-exist the road feel for the driver so that he can feel the road condition without experiencing the effects of moving over it.
5. To reduce tire wear and increase the life of the tire.

## 1.3 Steering Requirement

1. The steering should be very accurate and easy to handle.
2. The effort should be minimal and must not be tiresome to the driver.
3. Should provide directional stability. This implies that the vehicle should have a tendency to return to its straight ahead position after turning.

## 1.4 Zero Turning Radius Vehicles

Zero turn vehicle takes the sharp turn about a vertical axis passing through its center of gravity. For zero turn vehicle there is no need of additional space. The vehicle rotate in the circle having diameter equal to its length. The requirement of additional space is neglected. This system is used in jeep hurricane, Tata nanopixel, JCB, lawn mower.

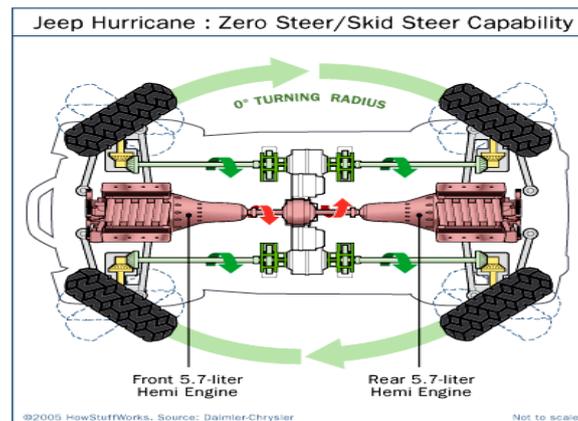


Fig.1.4 1 Zero turning radius mechanism in Jeep hurricane

The Jeep Hurricane which has many steering modes using four-wheel independent steering. Each wheel can turn independently from the other. The vehicle has two modes of four wheel steering. In first mode front tires and rear tires turns in opposite direction and reduces the turning circle. In second mode, front and rear wheels turn in same direction for crab steering, which facilitates parking at narrow space without changing the direction. The jeep hurricane can actually rotate in place, as shown in Fig. The Jeep hurricane has some limitations like requirement of skilled driver, complex steering system wear of tire.

## II. STEERING WHEEL CONFIGURATIONS

The various types of steering wheel configuration are as follows

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

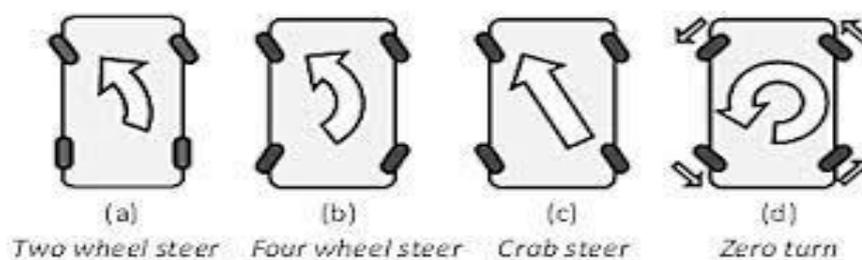
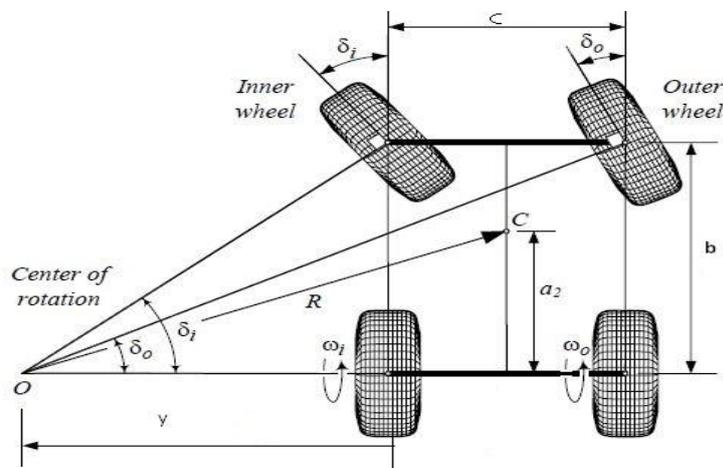


Fig.2.1. Steering wheel configurations

### III. ANALYSIS OF STEERING



**Fig.3.1. Steering angles for inner and outer wheel**

- Turning circle radius for the inner front wheel

- $RIF = \left(\frac{b}{\sin \delta_i}\right) - \left(\frac{a-c}{2}\right)$

- Turning circle radius for the outer front wheel

- $ROF = \left(\frac{b}{\sin \delta_o}\right) + \left(\frac{a-c}{2}\right)$

- Turning circle radius for the inner rear wheel

- $RIR = \left(\frac{b}{\tan \delta_i}\right) - \left(\frac{a-c}{2}\right)$

- Turning circle radius for the outer rear wheel

- $ROR = \left(\frac{b}{\tan \delta_o}\right) + \left(\frac{a-c}{2}\right)$

### IV. MATERIALS AND CONSTRUCTION

#### Basic components

The basic construction and main components of the Zero turn vehicle is given below,

#### 4.1. 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.

#### 4.2. D. C 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

### 4.3. Pneumatic Cylinders

In pneumatic cylinder power of compressed gas is used to produce reciprocating linear motion. Hydraulic cylinders having piston which move in a desire direction and piston rod transfers the force which is developed to the object. 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.

### 4.4. 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

### 4.5. Hose

Hoses are made completely flexible to carry high pressure compressed air

### 4.6. Links:

A link is a rigid body which has two nodes which are use 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

Binary link - with two nodes.

Ternary link - with three nodes.

Quaternary link - with four nodes

A joint is used to connect two or more links, which gives some motion between the links which are connected.

Joints are also called kinematic pairs. These can be classified in several ways:

1. By the type of contact in between the two, points line, elements or surface.
2. By the number of degrees of freedom at the joint.
3. By the type of physical closure of the joint: either force or form closed.
4. By the number of links joined.

The term lower pair describes joints with surface contact as with a pin enclosed by a hole and the term higher pair describes joints with point or line contact. However, if clearance is present between pin and hole must be for motion, surface contact in the pin joint actually becomes line contact, as the pin contacts only one side of the hole. Likewise, at a microscopic level, a block sliding on a flat surface actually has contact only at discrete points, which are the tops of the surfaces' asperities. The advantage of lower pairs over higher pairs is their better ability to trap lubricant between their enveloping surfaces. This is especially true for the rotating pin joint. The lubricant is more easily squeezed out of a higher pair, none developing joint. As a result, the pin joint is preferred for low wear and long life, even over its lower pair cousin, the prismatic or slider joint. The revolute and the prismatic pairs are the only lower pairs usable in a planar mechanism. The screw, cylindrical, spherical, and flat lower pairs are all combinations of the revolute and/or prismatic pairs and are used in spatial mechanisms.

## 4.7 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 protects from short circuit.

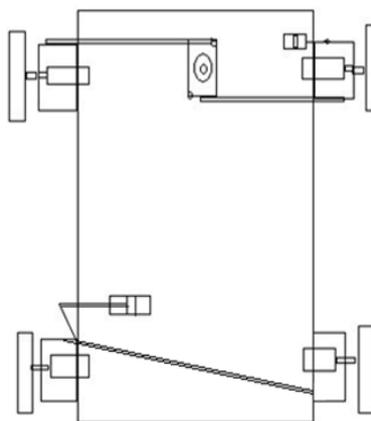
## 4.8. Wheels:

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.

## V. WORKING

### Working Principle

It is based on the principle of pneumatic system in which compressed air is used to turn the all wheels of vehicle to turn the vehicle in circular path. Zero turn vehicle means the vehicle which take the sharp turn with zero turning radius and follow exact circular path without leaving its vertical axis passing through the center.

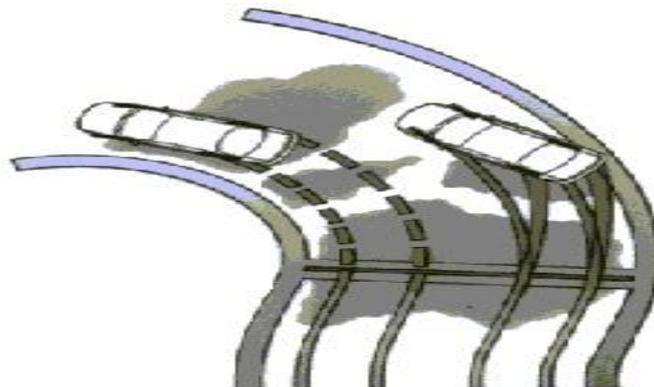


**Fig .5.1. Block Diagram of Zero Turn Vehicle**

The air is pressurized in the compressor. The compressor is used to pressurize the air due to which the temperature of the air increases. This pressurized air is supplied to the actuator through DCV. It controls the path of the air. The hoses carry the air between DCV and actuators. The rod of actuator is connected to the wheel through the mechanical linkages. Due to movement of the piston, linkages are also actuated which gives desire movement to the wheels of the vehicle. The dc motors gives the four wheel drive to each wheel. The dc motor can be rotate in both direction like clockwise and anticlockwise which are control by controller. An adapter is used which converts the ac current in dc current and gives to the dc motor. Normal steering system of the vehicle is regulated by dc motor. When supply of compress air is start, DCV is manually operated to tilt the wheels to take zero turn. At that same time the dc motors are actuated by means of controller and give the drive to the vehicle so that it can take zero turn. When there is no requirement of the zero turn the lever of DCV is put into normal position and vehicle can move as per normal vehicle.

## VI. RESULTS

According to research of various scientists they proven that zero turn vehicle or four wheel steering system is convenient over the two wheel steering system. The turning radius for a four wheel steering system is less than the two wheel steering system also it takes a sharp turn.



**Fig 5.1.1: Comparison between two drives**

## VII. FUTURE SCOPE

With the increasing number of future vehicle registrations, traffic and parking space problems become intensified. Hence there is a need of a suitable steering mechanism on a vehicle, which gives comfort and abide parallel parking, parking issues in a well-organized manner, is necessary. This project focuses and aims on designing an All Wheel Steer platform, which is capable of achieving Zero Turn Radius. It forms a solution for above discussed problem. Zero Turn Radius steering mechanism drive wheels in a unique manner such that four wheels of the vehicle follow a exact circular path, so that the chassis/platform will be capable of rotating about a fixed point. Hence, this would reduce the requirement of moving the vehicle in a defined path with large turn radius, as employed in traditional steering systems.

## VIII. CONCLUSION

A vehicle containing user friendly steering mechanism and low cost has been introduced. Based on the results of analysis following conclusion are drawn. The vehicle's cornering behavior becomes more stable and controllable at low speeds as well as on wet or slippery road surfaces. The vehicles response to steering input becomes quicker and more precise. The vehicle's straight-line stability is improved during zero turning. By steering the rear wheels in the direction opposite the front wheels at low speeds, the vehicles turning circle radius is greatly reduced. Problems like vehicle maneuvering on narrow roads and during parking becomes easier. This system reduce parking and turning time. We can achieve zero turn without any compromise in steer ability and handling of the vehicle.

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