DESIGN AND FABRICATION OF 360 DEGREE ROTATING VEHICLE FOR PARKING SOLUTION

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Abstract : The design and fabrication of 360 degree wheel rotation vehicle using servo motor is done to reduce time to turn from one direction to other direction while parking. Present study aims for development of a system to reduce the turning radius of vehicle. 360 degree rotating vehicle for parking solution includes a steering wheel, fixed at the rear end, for the front wheel driven vehicles. Driven by a servo motor with the help of screw the steering wheel moves down in the vertical direction to lift the rear end of the vehicle off the ground, and a cable is used for steer the wheel for any inclination to achieve the exact steering angle. For the rear wheel driven vehicles, the steering wheel is fixed at the front end. A control system controls the vertical and angular movement of the steering wheel. In this system at first vehicle is stopped and wheels are then turned in the required direction with help of servo motor, screw jack and cables. For heavy vehicles instead of one steering wheel the system includes two or more steering wheels. In another embodiment instead of servo motor and screw jack, hydraulic cylinders or pneumatic cylinders are used.

Index Terms : Servo motor, turning radius, Steering wheel system, Control system, Hydraulic and pneumatic cylinders.

I. INTRODUCTION

Work is about 360-degree rotating vehicle. This vehicle moves in all directionsand this design provides better comfort and also saves the time, most of the people uses this vehicle to carry goods, emergency patients etc. The normal wheel vehicles face lot of problems like parking, U turn and much more which consumes more time. So, we have designed a 360-degree wheel rotating vehicle to reduce and eliminate problems in the industry as well as common life of people. The vehicle can take a turn without moving the vehicle. No extra space is required to turn the vehicle. Consequently, we can utilize this 360-degree rotating vehicle from various perspectives like to transport things overwhelming bagsand furthermore in vehicles, which will help in decreasing rush hour gridlock and spare time.Zero degree turning radius of a vehicle implies the vehicle rotating about an axis passing through its centre of gravity of a vehicle i.e. the vehicle turning at the same place, where it isstanding. No extra space is required to turn the vehicle. So, vehicle is to be turned in the space equal to the length of vehicle itself. i.e. the vehicle has zero turning radius. This helps in maneuvering the vehicle in tight spaces such as parking lots and within small compounds.

II. OBJECTIVES AND COMPARISON OF ORTHOGONAL STEERING SYSTEM AND PROPOSED STEERING SYSTEM [1]

II.I PROPOSED STEERING SYSTEM

The steering systems now available in the country, as well as in foreign countries, have a minimum turning radius of about 6 meters for the standard vehicles as explained in details in the following paragraphs, whereas the present invention can reduce the turning radius to about 2.28 meters. In the present days the biggest problem facing the motor drivers in the city is for parking the vehicle. Very often the vehicle has to be parked in far off places and the driver has to walk back the whole distance. According to the latest statistics the increase in the number of vehicles for the next 5 years will be minimum 250%. The introduction of small cars will make the situation worst. By the year 2013 the parking and the pollution is going to be the biggest problem facing the motorists.

There are electronic devices, such as sensors, which can act as parking aids; and rear-view cameras enabling the driver to view the rear of the vehicle. These devices will be definitely helpful to the driver to minimize accidents while parking; but does not increase the maneuverability of the vehicle.

There are only two other known systems for reducing the steering radius of the vehicle. The details are available in U S Patent specification nos: 38,56,102, 44,98,554 and 43,15,555. 1. 4-wheel steering system. The system has been explained in details in the following pages. In this system the steering point has been brought nearer to the vehicle by steering all the four wheels. The steering radius has been brought down to about 3.65 meters, obviously quite larger than the 3-wheel system. The disadvantages of this system are as follows. The vehicle needs 4-wheel drive which obviously increases the fuel consumption, due to increase in the resistance. While the front end of the vehicle turns towards left, the rear end suddenly turns towards right. This could cause major road accidents, and there by restricts the maximum driving speed. If at all the rear wheels are to be disconnected for normal run, it needs complicated mechanism. In such a situation, by maintaining the rear wheels in the straight position the steering point will not fall on the extension of the rear axles, and the vehicle cannot steer without skidding. In the 4-wheel system, while steering, the front and the rear end of the vehicle keeps on moving, and therefore is not much helpful for parking, where as in the 3-wheel system the vehicle practically rotates keeping the inner front wheel almost stationary. Thus, the rear end of the vehicle can be easily pushed into the parking bay. 4- wheel system is also very expensive.

There are different types of power steering systems available in the country. The power steering system can only reduce the strain of steering the vehicle; but cannot reduce the steering radius. There are also steering linkage mechanisms which can quicken the movement of the steering wheels; but cannot reduce the steering radius.

II.II ORTHOGONAL STEERING SYSTEM

In this system the vehicle can be steered with a short radius by braking any of the front wheels at a time and driving the opposite wheel. There is no steering principle involved in this case. The rear wheel skids, resulting in excessive tyre wear and sometimes tyre damages. These two systems can be used only for " lifting vehicles" and earth moving vehicles which normally operates at very slow speed. In fact, the 4-wheel steering system has been already tried by Mazda and Honda motors in their passenger vehicles during the period from 1990 to 2000; but later withdrawn due to operational problems.

III. FABRICATION

III.I COMPONENTS

D C Servomotor: It is the main component of this system. Servo motor gives the required power to lift the vehicle from ground

Gear: It converts rotary motion of motor into linear motion of screw jack. Here 2 gears are used for the purpose of speed reduction and torque adjustments

Screw thread: Screw thread makes the up and down motion of center wheel

Wheel: by using an additional wheel at the centre of rear wheel axis we can lift the vehicle from the ground about 2-3 inches and can be used to move

III.II WORKING

Short radius steering system for parking vehicles comprises of a steering wheel suspended from the rear axle bar, for the front wheel driven vehicles, which can be moved up and down by a screw jack. The wheel hits the ground and lifts the rear of the vehicle and thus the vehicle rests on its own front wheels supported by the additional rear wheel. During the turn the front wheels will be held in the normal position.

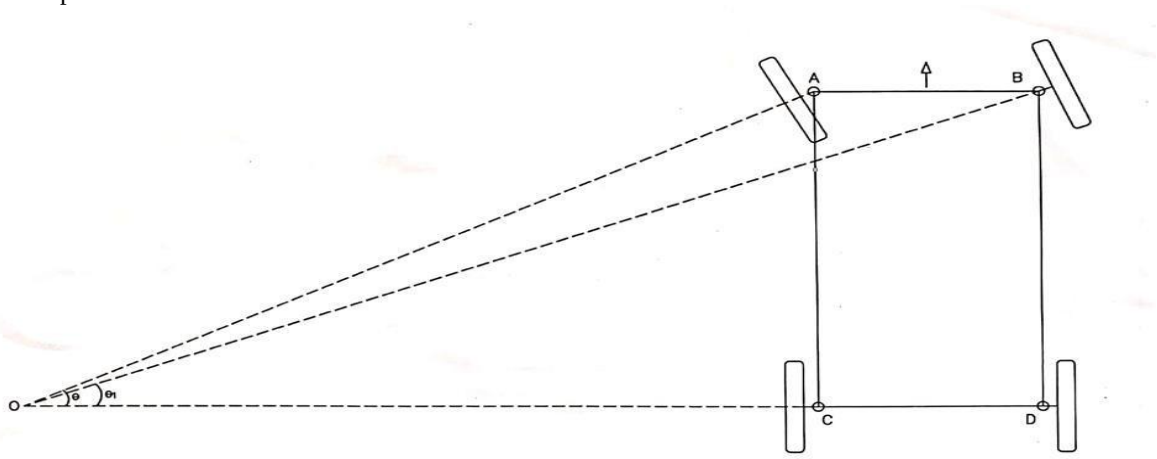

Fig. 1 A Conventional Steering system

In figure 1 indicates the conventional steering system. The front wheels arc mounted on short axles pivoted at A and B. When the axis of these two axles arc produced, they meet at a point 0 on the straight line passing through the axles of the rear wheels. This point is known as "instantaneous center", with respect to which 4 wheels describe 4 concentric arcs when the vehicle turns. Normally angle AOC is appro: 23 degree and angle BOD is 20 degree for small cars. The biggest radius i.e. 013 is known as "steering radius" and this works out to appro: 6 meters, when the distance between the pivot points i.e. AB is 4 ft. and the wheel base AC is 7 ft. For a perfect skid less steer the equation is Cot 01 — Cot 0 = CD / AC.

In figure 2 indicates the proposed steering system. Z is the position of the additional wheel positioned at right angle to the line OZ, i.e. appro: 23 deg:, with the rear axle CD. The straight line passing through the axle of this wheel, meets at a point 0 on the straight line passing through the front axles, at about 1 ft. away from the pivot point on LS. This will be the new instantaneous center, with respect to which the 3 wheels will make 3 concentric arcs when the vehicle turns in the forward or reverse direction towards left. The turning radius in this case is OZ which is much shorter and works out to appro: 2,28 meters. 11 and Z2 are the positions of the additional wheel after the vehicle turned through 90 deg: towards left, in forward and reverse direction.

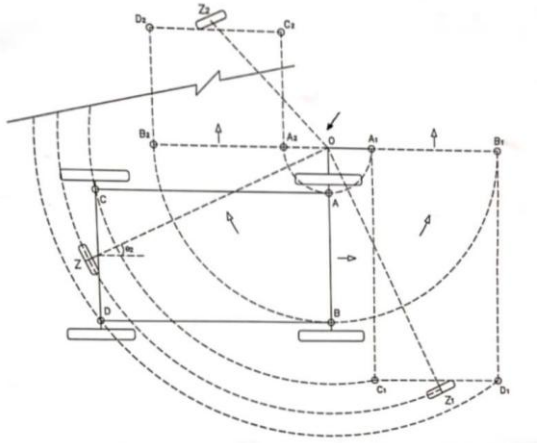

Fig. 2 Proposed Steering system

In, figure 3 indicates the proposed steering system when the vehicle turns towards right. Z is the position of the additional wheel fixed at right angle to the line 01, i.e. appro: 23 deg: with the rear axle DC. The straight line passing through the axle of this wheel meets at a point 0 on the straight line passing through the front axis at about 1ft. away from the pivot point on right side. This will be the new instantaneous center, with respect to which the 3 wheels will make 3 concentric arcs when the vehicle turns towards right. The turning radius in this case is OZ and works out to be the same i.e. 2.28 meters, as in the case of Fig. 3. 11 is the position of the additional wheel after the vehicle turned through 90 deg: towards right, in forward direction. The vehicle can also turn through 90 deg: towards right in reverse direction, with the same turning radius.

Fig. 3 also indicates the 4-wheel steering system developed in United states. When the front wheel steers to the right, the rear wheel steers to the left, as the vehicle turns to right. The instantaneous center in this case will be 01. The right side 2 wheels will describe a common arc with 01 B=01 D as radius, and the left side 2 wheels will describe another common arc with 01 C= 01 A as radius. These two arcs which are concentric will have their instantaneous center at 01. In this case the turning radius will be C 01 which is equal to A 01. Even if the inner wheels steer through 23 deg: the turning radius will not be less than 3.65 meters.

In the case of rear wheel driven vehicles, the additional wheel is attached at the front end and the steering point will be on the straight line passing through the rear axles of the vehicle.

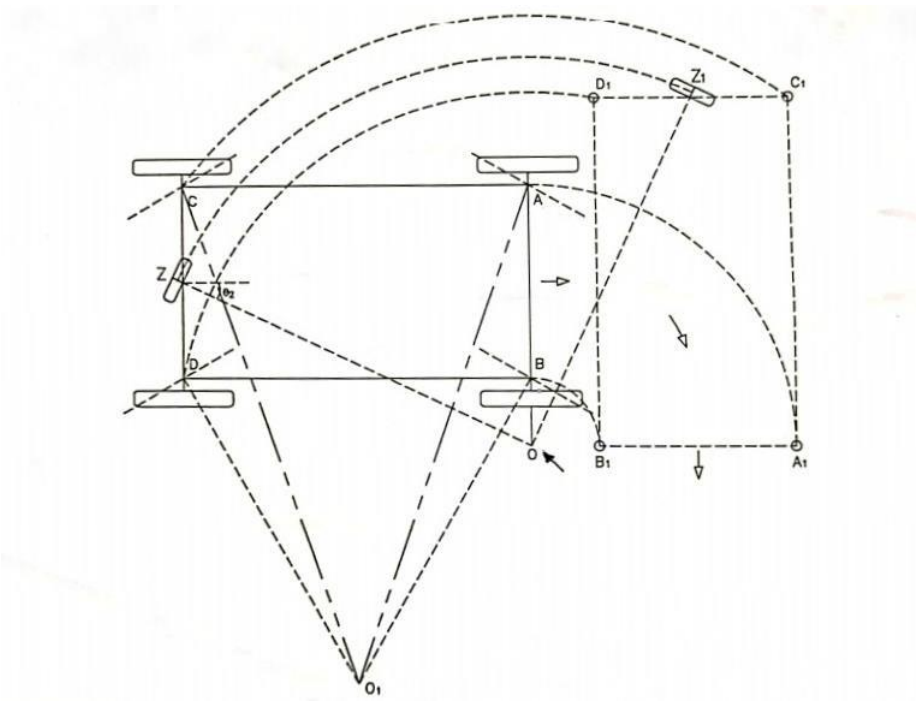

Fig. 3 Proposed Steering system when vehicle is turned right

IV. DESIGN

The invention is more clearly described below with reference to the accompanying drawing. Figure 4 is an assembly of the system. Part 1 is the D C servo motor of approximately 59341.327 N mm torque and 621.42 W power, used for moving the additional rear wheel up and down. Part 2 is the gear made up of cast steel which is used to transmit the rotational motion of the motor to the screw thread. Part 3 is the screw thread used for the up and down movement of the system is made up of steel. Part 4 is the additional rear wheel, used for steering the vehicle in particular direction and angle and also helps to steer the vehicle

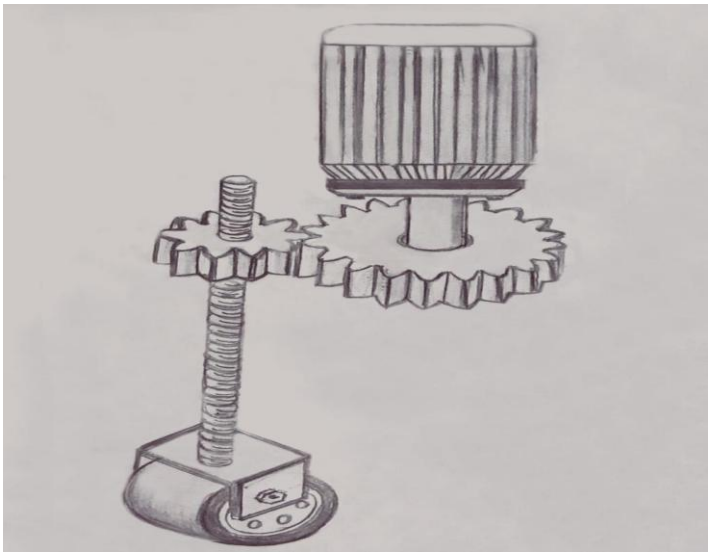

Fig. 4 Assembly of the system

IV.I DESIGN REQUIREMENTS

To reduce the turning radius of four-wheel front drive vehicle

To overcome the parking problems

Specifications

- Turning radius reduction: from 5meter to 2.3 meter
- Maximum load of the vehicle: 4900 N
- Number of passengers allowed: 1
- Assumed weight of driver: 80 Kg

Vehicle lift height: 5 Cm

IV.II DESIGN PARAMETERS

Screw

• Material: - steel

• Load = 4900 N

Diameter,dm = √(2w/πΨσbr) from PSG Databook= √(2x4900/πx2x8) Ψ = 2=13.96 mm σbr = 8 N/ mm²=14.00mm

(From PSG Databook)

outside diameter, do = 14 mm

inside diameter, di = 12 mm

∴ Mean Día , dmean = (do + di) / 2= (14 + 12) / 2= 13 mm

Torque:

T = Wd2/2Xtan(Φ+α)12= Wd2/2 [(tanΦ+tanα)/1-tanΦtanα]= [(4900x32.5)/2] x [(0.3+0.3639)/(1-.3x.3639)]= 79625 x 0.74526 = 59341.327 Nmm

α = 20°

tanΦ = 0.3

POWER, P = (2πNT)/60= (2X πX100X 59341.327)/60= 621.42 W

Hence select a motor with about 621W power

Nut

Material: - cast iron

Ψ = H/dm = 2

i.e. 2 = H/13

H = 26 mm

Considering factor of safety as 1.5

∴ Height, H = 26X1.5= 39 mm

Number of threads, n = H/P=26/2=13nos

Gear

POWER, P = 624.42 W

Module, M = 2.5

Pitch circle diameter = 80 mm

Ft = P/V V= πdn/60=621.42/0.418 = (π x 80 x 100)/60=1486.65 N =0.418 m/s

FD= (Ft x Cs) / Cv, Assume Cs=1

= (1486.65 X 1)0.9163 Cv =4.58/(4.58+V)=1622.44 N =4.58/ (4.58+0.418)=0.9163

Gear material Cast steel 0.20%C untreated

σb =138.3 (from Data Book , Page No : 234)

σb =345 (from Data Book , Page No : 230)

Fb = σb x b x Y x P b = 10m = 10 X 3 = 30

P = πm = π x 3 = 9.42

Y = (0.154 – (0.912/ Z) Page No :204

m=d/Z

Z=d/m = 80/3=26.667 ≈ 28

Y = [0.154 – (0.912/ 28)]=0.121

Fb = 138.3 X 30 X 0.121 X 9.42 =4729.11 N

Dynamic Load

Fd = Ft +Fi (from data book)

Fi = [K3 x V x (Cb + Ft)] / [K3 x V X √ (Cb +Ft)]

C = e /K1 x [(1/E1) + (1 / E2)]

K1= 9 (from Data Book)

E1=E2=2.05X 105 (For steel)

e = 0.0254 (from data book)

C= 0.0254 / [9 X (2.05X 105) +(2.05X 105)]=289.277

K3 = 20.67 (From data book)

Fi = [20.67 X 0.418 (289.277 X 30 +1486.65)] / [(20.67X 0.418) + √ (289.277 X 30 + 1486.65)] =802.345

Fd = Ft + Fi =1486.65 +802.345 =2289.99 N

V ADVANTAGES & DISADVANTAGES

V.I ADVANTAGES

- Reduction in turning radius
- Reduce the turning time
- Overcome parking problem

V.II DISADVANTAGES

- Complicated design
- Extra equipments needed
- More space utilization
- More battery power needed

VI. RESULTS & DISCUSSIONS

The present invention is directed to a short radius steering system, by shifting the steering point from the rear axle extension to the front axle extension, close to the inner front wheel, by incorporating an additional wheel at the rear end of the vehicle.
The system is intended basically for parking in the congested and narrow parking bays where the conventional steering system will find difficult to maneuver. The system employs only 3 wheels, le the front 2 wheels and the additional wheel at the rear, while parking. For serial parking (one behind the other) on the left side, the vehicle is driven at about 45 deg: into the parking bay. When the right side front wheel touches the boundary of the parking bay at about 2.5 ft away from the front end of the bay, stop the vehicle; switch on the parking wheel actuator; and move the vehicle choosing the "right side" option. The rear of the vehicle will now advance towards the rear of the parking bay. The vehicle will practically rotate keeping the front inner wheel almost stationary. Within a few seconds the vehicle will be automatically positioned within the parking bay. In the same manner the vehicle can be easily moved out of the parking bay by applying the reverse gear. The reverse function takes place for right side serial parking. For right side parallel parking, drive the vehicle along the right- side boundary of the passage. While there is about l ft. distance for the front wheel to reach the boundary of the parking bay, stop the vehicle; switch on the parking wheel actuator, and move the vehicle, choosing right side option. The vehicle will now make a right angle turn and enter the parking bay. There is no need for the driver to steer or to look back. In the same manner the vehicle can be easily moved out of the parking bay by applying reverse gear. The reverse function takes place for left side parallel parking.

VI CONCLUSIONS

A prototype for the proposed approach was developed by introducing steering and servo motor to wheel rotate 360 degree. Thus, it is concluded that vehicle can be allowed to guide vehicle in all direction. 360 degree of rotating automobiles and also, we can guide in parallel direction. In recent time the advancement is made in automobiles. So, it has been modified in such a way that it can save time and also easily work with many problems. This can give fast response and less space is required. The developed model is recommended for inclusion in the cars in various area such as small industries, railway platforms. The foregoing discussion discloses and describes the exemplary embodiments of the present invention. One skilled in the art will readily recognize from such discussion and from the accompanying drawings and claims that various changes, modifications and variations can be made therein without departing from the true spirit and fair scope of the invention as defined by the following claims. As example, the spare wheel of the vehicle itself can be substituted for the steering wheel by making suitable changes in the construction of the vehicle body

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