360 Degree Wheel Rotation Vehicle

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Abstract *: The design and fabrication of 360 degree wheel rotation vehicle using DC motor and steering is done to reduce time to turn from one direction to other direction. This vehicle can move in all direction at a same position by used of steering, sprocket, DC motor, bearing and chain drive. Main function of this vehicle is easy to move from one direction to other direction. Modern development and economical progression of Indian society resulted in increase of people on railway platform, increase of vehicle on the road,due to space constraints, in hospital is major problem of the country. Present study aims for development of a system to reduce the turning radius of vehicle.In this system at first vehicle is stopped and wheels are then turned in the required direction with help of steering system and DC motor. It has turning radius nearly equal to negligible of length of the vehicle itself.This vehicle used to carry the goods in various area such as, railway platform, hospital, industries and market.*

Keywords: *Bearing, Chain drive, DC motor, Sprocket, Steering and wheel*

1. Introduction

This project is about design of 360 degree wheel rotating vehicle. This vehicle moves in all directions and this design provides better comfort and also saves the time of customers, most of the people using this vehicle to carry goods, patient etc. But most of the time, they have to face the problem like taking U turn etc. So have to design a 360 degree wheel rotating vehicle to reduce and eliminate problems in the industry and at the railway platform. Zero degree turning radius of a 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 is to be turned in the space equal to the length of the vehicle itself. In this system, steering is connected to sprocket and this sprocket is connected to sprocket of front wheel by chain drive. Steering is used to provide the direction of front wheel. The DC motor is connected to sprocket bolt at above of frame. When power supply from battery to DC motor then rotary motion transfer from DC motor to the wheel. The bearings are provide below sprocket which allow to wheel rotate 360 degreeabout vertical axis. Then this same rotary motion is transfer to the rear wheels by sprockets and chain drive arrangement. So as a result this arrangement of the vehicle wheels to turn 90 degrees left and 90 degree right from original position, but front wheels of this vehicle rotate 360 degree by steering, sprocket and chain drive arrangement. Without moving from the spot, 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.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.

2. Literature survey

The idea of 360 degree wheel rotation load carry vehicle is analyzed from;

Jaishnu Moudgil, et al. [1], presented a 360 degree rotating car to overcome the problem of parking space. This car has zero degree turning radius of a 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 is to be turned in the space equal to the length of the vehicle itself. In this presentation, so got idea of 360 degree wheel rotation vehicle and have plane to make 360 degree wheel rotation load carry vehicle, this vehicle is to be used in different area like industries, hospital, railway platform, etc.

Sudip kachhia [2],presented a 360 degree rotating vehicle to overcome the problem of parking space. This project is about design of 360 degree rotating car to move in all direction. This design provides better comfort and also saves the time of customers, that's why it is also the reliable for the customer. As it is also

battery operated car thus no fuel is required. Hence it is economical to the environment. This also reduces the cost of the car, and also got idea to use battery to operate this vehicle.

K. Lohith, et al. [3], presented a four wheel steering system for a car. In four wheel 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 with the use of DC motor to turn left and right. In this presentation, the use of DC motor is to rotate the wheels 90 degree left and 90 degree right from original position.

Er. Amitesh Kumar, et al. [4], presented zero turn four wheel steering system, 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 project the use of steering is to rotate front wheels.

Mr. Sharad P. Mali, et al. [5], presented zero turn four wheel mechanism, in this project people have used DC motor and wheel to vehicle rotate 360 degree at a same position. So in this project, the idea is to arrange of DC motor and wheel.

3. Design

Design of 360 degree wheel rotation vehicle adopted to easily move in required direction. This vehicle is mainly consist of DC motor, steering, sprockets, chain drive, iron pipe, bearing, and wheels. The basic arrangement of the 360 degree wheel rotation vehicle is as shown in Fig. 1.
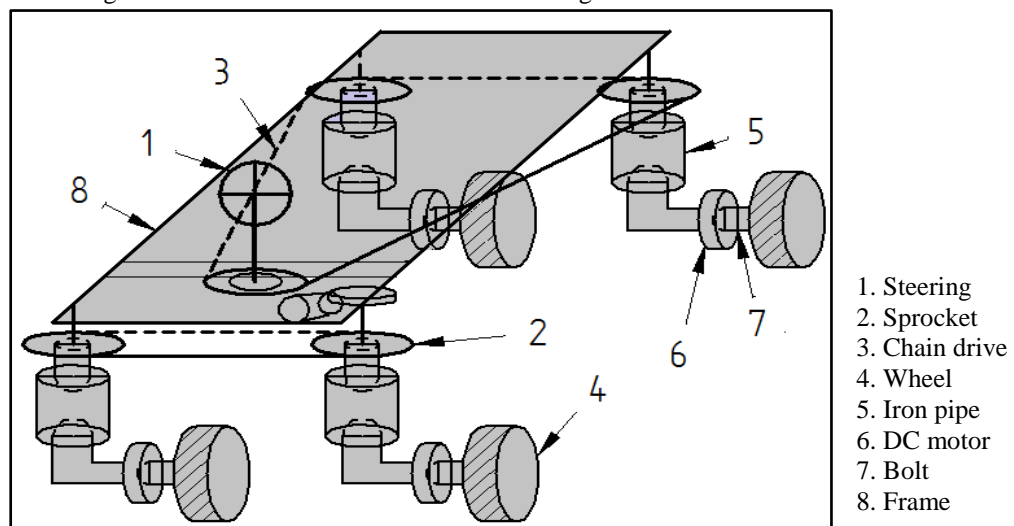

1. Steering
2. Sprocket
3. Chain drive
4. Wheel
5. Iron pipe
6. DC motor
7. Bolt
8. Frame

Fig. 1 360 degree wheel rotation vehicle

4. Design calculation

Design parameters considerations are;

4.1 Motor calculation

Specification and calculation:
➢ 60 rpm
➢ 12 V
➢ 18 W

Torque of motor: $\zeta = \dfrac{P \times 60}{2 \times 3.14 \times N}$ (1)

$= \dfrac{18 \times 60}{2 \times 3.14 \times 60}$

$= 2.866 \text{ Nm}$

$= 2.866 \times 10^3 \text{ N-mm}$

The motor shaft is made of MS and its allowable shear stress (F_d)= 42 MPa

Torque: $\zeta = \dfrac{3.14 \times F_d \times d^3}{16}$ (2)

$5.72 \times 10^3 = \dfrac{3.14 \times 42 \times d^3}{16}$

d = 7.031 mm

The nearest standard size is d = 8 mm.

4.2 Calculation of position of center of gravity with respect to the rear axle

We know that turning Radius of vehicle (R) = 1500 mm.

Also we know that,

Turning radius of vehicle: $R = a_2^2 + R_1^2$ (3)

Where,

a_2 = Distance of CG from rear axis.

R_1 = Distance between instantaneous center and the axis of the vehicle.

To find a_2

Load on front axel: $W_f = \dfrac{W \times a_2}{L}$ (4)

Where, W_f = Load on front axle = 17kg (On basis weight distribution)

Total weight of vehicle (W) = 30kg

Wheel base (L) = 2669 mm

Therefore,

a_2 = 1200 mm

Substituting the value of a_2 in the above equation

R_1 = 2010 mm

➢ If load apply on the vehicle is 25kg and length 600 mm, width of vehicle 800 mm.Find the reaction force developed by each wheel and also find torque of each wheel?
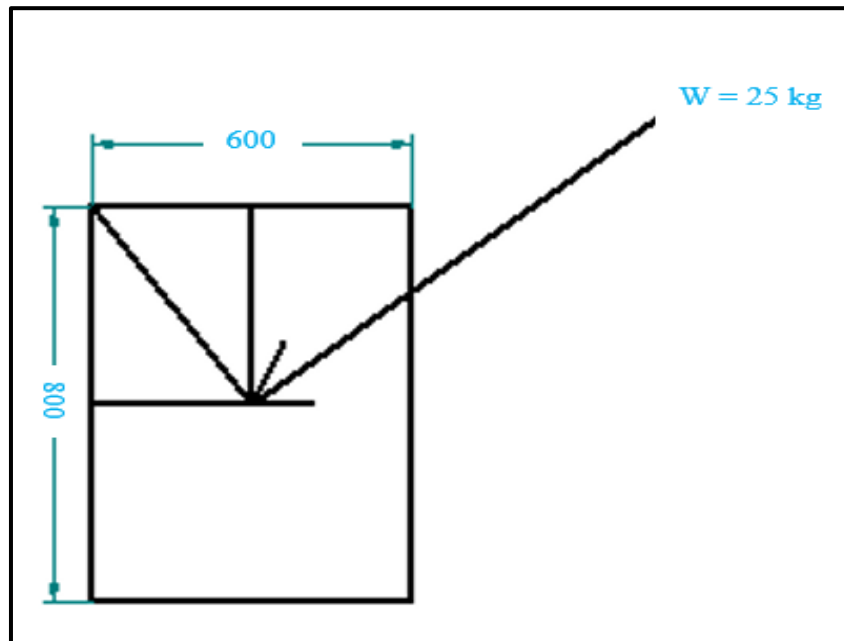
Here Given Data

W=25kg

Fig. 2force diagram

Length=600 mm

Width=800 mm

To find reaction force on each wheel (F), torque (T)

$r = \left(\left(\dfrac{a}{2} \right)^2 + \left(\dfrac{b}{2} \right)^2 \right)^{0.5}$ (5)

$r = \left(\left(\dfrac{600}{2} \right)^2 + \left(\dfrac{800}{2} \right)^2 \right)^{0.5}$

r=500 mm

Now

W= 25kg = 25×9.81 = 245.25N

Now

Force on each wheel $=\dfrac{W}{4}$ (6)

$=61.32N$

According to newton's 3rd law of motion

Reaction Force developed by each wheel: $F =\dfrac{W}{4}$ (7)

$= 61.32N$

Now

Torque on each wheel: $T=\dfrac{W}{4} \times r$

$= 30660$ N-mm

5.Working principle and components

This project consist of steering, chain sprocket,DC motor, wheel, bearing, iron pipe, battery and chain drive. In this system first the vehicle is stopped and wheels are then turned in the required direction with help of steering system and DC motor. Teeth of sprocket are completely mesh with chain drive which has used to provide rotary motion to rear wheels by help of DC motor. Steering is used to provide direction of rotation to front wheels by help of sprocket and chain drive arrangement. DC motors are used in each wheel to provide forward and backward movement of this vehicle, also a battery is used to provide electrical energy of each DC motor. It has turning radius nearly equal to negligible of length of the vehicle itself. This system is to be useful in hospitals, small industries and also on railway platforms.

➢ 360 degree wheel rotation vehicle consist of steering, chain sprocket, chain drive, iron pipe, battery, DC motor and wheel.

➢ In this vehicle sprocket of front wheel and sprocket of steering are connected by first chain drive and sprocket of rear wheel connected to second chain drive and DC motor has is given to each wheel to provide forward and backward movement of vehicle.

➢ When steering is to rotate clockwise and anticlockwise direction by hand then sprocket is connected with steering also rotates clockwise and anticlockwise direction. This rotary motion transfers to front wheels by chain drive because teeth of sprocket and chain drive are completely mesh to each other. Bearing is provided with sprocket which allows the wheel to rotate 360 degree. So as a result front wheels of this vehicle rotates in 360 degree direction by steering at a same position.

➢ When power is supplied from the battery to DC motor then DC motor starts to rotate in clockwise direction and also sprocket will rotate in clockwise direction because sprocket bolt is connected to DC motor, the same rotary force is transferred to other rear wheels by chain drive because sprocket of rear wheel are connected by chain drive and bearing has provide with sprocket which allow to wheel rotate. So as a result rear wheels also rotate 90 degree left from original position and reverse current flow from battery to DC motor then rear wheels rotate 90 degree right from original position.

➢ When power supply from battery to DC motors of each wheels then each DC motor starts rotate then wheels also rotate with DC motor because wheels and DC motors are connected by bolts and nuts. As a result vehicle moves in forward direction and when reverse current flow from battery to DC motors, then DC motors start rotate in opposite direction. As a result vehicle is move in backward direction.

The main components used to fabricate the model are:
➢Steering
➢ Sprocket
➢ Chain drive
➢ Wheel
➢ Iron pipe
➢ DC motor
➢ Bearing
➢ Fixed frame
➢ Battery

5.1 Steering

Steering is a part of 360 degree wheel rotation vehicle. This part is used to provide the direction to the front wheels by help sprocket and chain drive, which providesdirection to the front wheels clockwise or anticlockwise direction.

5.2 Sprocket

A sprocket is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain. The sprockets are used for the power transmission between steering and wheel through the roller chain drive. A sprocket is a profiled wheel with teeth that meshes with a chain, track or other perforated or indented material. Chain sprocket is a part this vehicle. Chain sprocket are used to provide the clockwise or anticlockwise direction to front wheel and rear wheel through the chain drive. Sprockets are used in bicycles, motorcycles, cars, tracked vehicles, and other machinery either to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc.

5.3 Roller chain

A roller chain is the type of chain driven most commonly used for transmission of mechanical power between two sprockets. It consist of a series of short cylindrical rollers held together by side links. It is driven by a toothed wheel called a sprocket.It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. In this vehicle first chain drive connected with sprocket of front wheel and sprocket of steering and second chain drive is connected with sprocket of rear wheel.

5.4 Wheel

In this vehicle wheels are made of plastic material. Wheel are connect with DC motor and front wheel rotate 360 degree by help of steering, chain sprocket, chain drive and bearing arrangement. The rear wheels rotate 90 degree left and 90 degree right from original position by help of DC motor, sprocket and chain driver arrangement, DC motor has given to each wheel to provide forward and backward movement of wheel.

5.5 Iron pipe

Ironpipe is a one of important parts of 360 degree wheel rotation vehicle. It is made of mild steel. Which is used to connect bearing and DC motor of each wheel.

5.6 DC motor

In this vehicle one DC motor are provide in each wheel to move forward and backward direction. The specification of motor used is 12 V, with 60 rpm.When power supply from battery to DC motor then DC motor rotate in clockwise direction and when reverse current supply from battery to DC motor then DC motor will anticlockwise direction. Which will forward and backward movement of vehicle. An electric motor uses electrical energy to produce mechanical energy. In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

5.7 Bearing

In this vehicle bearing is use easy to move wheel from one direction to other direction, each bearing is connected with each wheel with the help of sprocket and iron pipe.A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction.

5.8 Fixed frame

The fixed frame forms the base of the 360 degree wheel rotation vehicle. This frame is made of Mild Steel (MS). It has four wheels attached to its two sides by sprocket bolt and iron pipe.

5.9 Battery

Battery is one of the important parts of 360 degree wheel rotation vehicle. Which is connected to DC motor by electric wire. It is store electrical energy and supply to DC motor so vehicle will move forward and backward direction. Batteries operate by converting chemical energy into electrical energy through electrochemical discharge reactions. Batteries are composed of one or more cells, each containing a positive electrode, negative electrode, separator, and electrolyte. Cells is to be divided into two major classes primary

and secondary. Primary cells are not rechargeable and must be replaced once the reactants are depleted. Secondary cells are rechargeable and require a DC charging source to restore reactants to their fully charged state.

6. Fabrication details

The fabrication details with assembled model are shown below:

6.1 Assembled model

The Fig. 3 and Fig. 4 show the assembled model of proposed system.

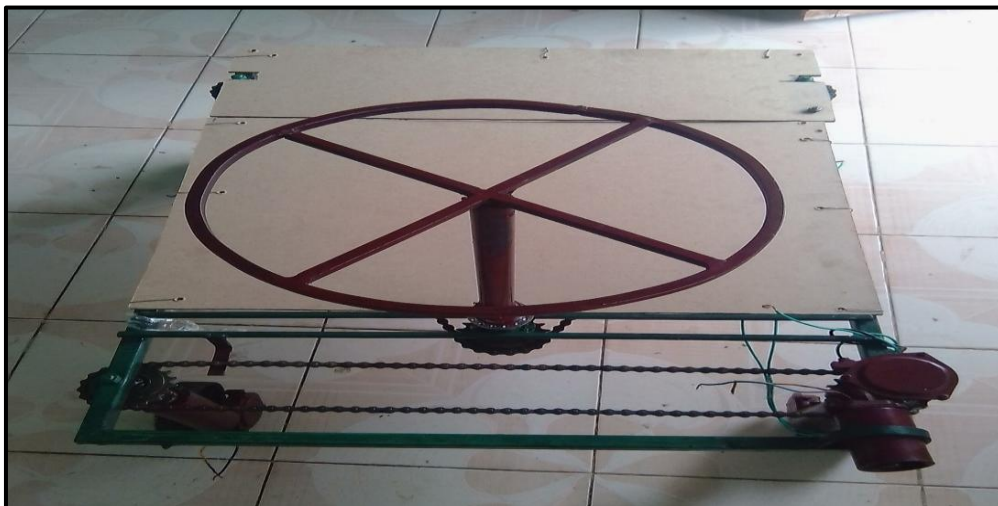**Fig. 3 the side view of assembled model**

Fig. 3 the top view of assembled model

6.2 Performance analysis

The performance analysis of the 360 degree wheel rotation vehicle has clearly shown that it is more efficient, economical and effective.In this project forward and backward movement of vehicle and turning of rear wheel of the vehicle are getting power from the battery in the form of an electrical energy. This energy is has stored into a 12V battery and then supplied to the components. As the electrical power is used and transmitted to components by the use of electrical wires in place of any mechanical arrangement, this results in less noise, less wear of components and less vibration. Use of battery provides a smooth flow of current toward the components. Most of time people are facing problem in parking and railway platform because other vehicle are taking more space to move from one direction to other direction. But developed 360 degree wheel rotation vehicle this problem easily solved. Because this vehicle has capability to move from one direction to other direction in very less space. In this project a DC motor and battery are used according to load carry capacity which is of 5 kg, but vehicle able to carry more load if use more than 12V of battery.

7. Advantages, disadvantages and application
Advantages, disadvantages and application of 360 degree wheel rotation vehicle shown below;

7.1 Advantages
➢ It consumes very less time to turn from one direction to other direction.
➢ It is more efficient compare to other type of load carry vehicle.
➢ This type of load carry vehicle is easily parked in any direction.
➢ It is less costly load carry vehicle.
➢ Eco friendly.
➢ Less noise operation.
➢ Battery operated thus no fuel required.
➢ More efficient.
➢ Battery is using in this 360 degree wheel rotation vehicle to move forward and backward, so it is a kind pollution free vehicle

7.2 Disadvantages
➢ This type of load carry vehicle is not applicable to carry more weight.
➢ Battery power is required to move of the vehicle.

7.3 Application
➢ In Industries for automation of raw material like automated guided vehicle.
➢ In automobile sector there are so many types of vehicle are using to carry goods from one position to another position, there is space problem in the industry so this vehicle is used in automobile applications because this vehicle consumes very less space compare to other type of vehicle.
➢ This vehicle is used in small Industries for transportation of raw material from one position to another position.
➢ Modern development and economical progression of Indian society resulted in increase of vehicle in park so there are also problem. In park other vehicle are taking more space to move from one direction to other direction and 360 degree wheel rotation vehicle have capability to move parallel direction so this vehicle is easily move from one direction to other direction in park.
➢ Take easily U-turn because front wheel of this vehicle are rotating freely by steering, chain drive and sprocket arrangement.
➢ It is used in hospitals to carry the patient from one room to another room. Because there are lots of patients those are staying in one room.

8. Conclusion
A prototype for the proposed approach was developed by introducing steering and DC motor to wheel rotate 360 degree. This prototype was found to be able to be maneuvered very easily in tight spaces, and after manufacture of 360 degree wheel rotation vehicle consumed very less space to turn from one direction to another direction and it consumes less time to turn and this vehicle used in various area such as small industries, railway platforms.

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