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Fabrication of modified steering and drive mechanism for turning wheels through 90 degree in parallel parking

Ravi Shankar*, Kumar Saumya*, Sujeet Kumar*, Saurabh Kumar*, Praveen Kumar *, Jitendra Kumar *, Ashis Saxena[#] and Hitendra Bankoti[^]

**Research Scholars, Department of Mechanical Engineering,*
Amrapali Institute of Technology & Sciences, Haldwani, India
[#]Department of Mechanical Engineering, Amrapali Institute of Technology & Sciences, Haldwani, India

ABSTRACT: In this paper, an effort is made on the development, modification and fabrication of steering and drive mechanism which will result in turning of wheels by 90 degree for easy parallel parking. The proposed approach is to construct a vehicle whose wheels can turn 90 degrees by using an additional rack and pinion type steering system for the rear wheels in addition to front steering system. Rear wheel steering mechanism will come into action at the time of parallel parking and can be engaged or disengaged with the help of a lever which in turn operates the engagement /disengagement pin. In addition to this, turning angle of wheels is increased to 90 degree by eliminating tie rods and using a longer rack. A cylindrical pinion with length more than usual is connected to steering column via bevel gear and is used to move the rack in transverse axis (i.e. for side to side movement) to a greater extent resulting in 90 degree turning of wheels. In order to drive vehicle during parallel parking situations power must be given to all the four wheels along with steering. This is achieved by using a modified drive mechanism involving the use of four differential gear assembly at every wheel and two modified differential assemblies (D5& D6) in front and rear axle for transmission of power during parallel parking. Modified differential assembly D5in the front axle can be disengaged during normal driving conditions with the help of an engagement /disengagement pin which is driven by a lever.

I. INTRODUCTION

The most conventional steering arrangement is to turn the front wheels using a hand-operated steering wheel which is positioned in front of the driver, via the steering column, which may contain universal joints to allow it to deviate somewhat from a straight line. Primary function of the steering system is to achieve angular motion of the front wheels to negotiate a turn. This is done through linkage and steering gear which convert the rotary motion of the steering wheel into angular motion of the front wheels. For decreasing the turning radius and increasing the turning angle of wheels of vehicles for transverse parking various mechanisms are proposed one after another, some seemed to inspire but most of them failed to get commercialized.

Earliest one is "PIVO2" of Nissan which is based on 3600 swiveled electric Nissan concept and was eventually launched in 2007. This was a 3600 rotating three seated cabin on a chassis of four wheels, and hence eliminate the need of reversing and makes parking easier. It is powered with a lithium-ion battery, the wheels have been moved to rotating pods that allows the car to drive the car in any direction. Along with the rotating cabin, this allow the car to pull up next to a parking space, the wheels and cabs simply rotate 90 degree and the car drives in sideways. Each wheel contains a motor for transmitting power in individual.

Several other mechanisms were proposed for decreasing the turning radius of automobiles for better parking at confined spaces.

Worm gear and pinion arrangement based steering mechanism [1] Worm gears are used to transmit power at 90°, Compaq gear boxes and worm gear arrangement were used for every individual wheel. They used four motors and gear boxes for individual wheel which drive the wheel. In order to provide angular motion i.e. 90 degree in the wheels they used worm gear arrangement. While for rotating the wheel, they used two separate Geared motors.

Convertible four wheel steering with three mode operation[2] This concept was based on insertion and removal of lock nuts consisting of a steering setup, spur gears, bevel gears. The three modes were Front wheel steer, both front and rear wheel steer in same direction, both wheels in opposite direction. When the lock nut is removed, the steering operation is carried out in normal condition.

That is only front wheels steer. But when the lock nut is inserted, the other two modes can be used. When the gear arrangement is pushed to one position, the spur gears get engaged and the steering of rear wheel is ensured and is in same direction as that of the front wheels. When the gear arrangement is moved to other side, the spur gear disengages and the bevel gear gets engaged. Due to bevel gear arrangement, the rear wheel steers in opposite direction to the front wheel. This results in third mode steering.

Linkage based steering mechanism[3]Linkages are employed to transmit steering from steering wheel to wheels, Here a set of diagonal wheels are selected in which power and steering both systems are attached.

In the present project "Fabrication of modified steering and drive mechanism for turning wheels through 90 degree in parallel parking" we are using separate mechanism for transmission of power and for steering the vehicle. Again there will be two modes of operation in each case, one in case of normal driving i.e. normal mode and another which is used during parking i.e. parking mode.

II. METHODOLOGY

In the present work we have used two engagement/ disengagement levers, one for engaging and disengaging the steering on rear portion of vehicle and another for engaging and disengaging power on rearportion of the vehicle.

There will be two modes of operation one in case of normal driving i.e. normal mode and another while parking i.e. parallel parking mode.

A. Normal Mode

In this mode we will disengage the front side of power mechanism and rear side of steering mechanism. It is essential because when we are providing power to front wheels together with the steering system then the direction of bevel gears which is part of modified differential assembly will rotate in counter direction which will result in distortion of gears attached.

B. Parking Mode

In this mode we will engage power mechanism to front wheels and steering mechanism to rear wheels. This will result in 90^0turning of wheels through manual steering. If we are not providing power mechanism to front wheels then it will act as hinge and result in rotation of the vehicle.

Note- In this project we have used bike engine and chain drive is used for power transmission in both the axles which can be easily replaced by transmission system as used in four wheelers without any major change in the proposed mechanism.

Notations used- We are using various notations to identify each of the essential parts used to describe our mechanism.

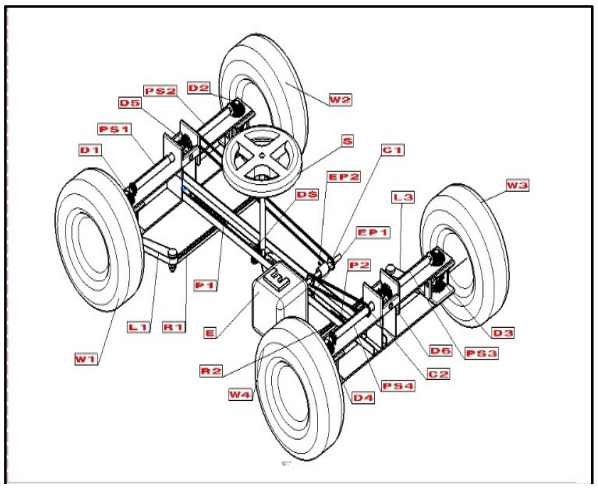

Fig. 1. Schematic diagram of the modified chassis with proposed mechanism.

Table 1. Notations used in the schematic diagram of proposed mechanism.

W1,W2,W3,W4	Wheels
D1,D2,D3,D4	Differentials at wheels
D5,D6	Modified differentials for power
DS	Bevel gear sets for steering
S	Steering wheel
EP1	Engagement pin 1(rear steering engagement/disengagement)
EP2	Engagement pin (front wheel power engagement /disengagement)
L1,L2,L3,L4	Steering arms
P1,P2	Pinions
R1,R2	Racks
E	Engine
C1	Chain drive at rear axle
C2	Chain drive at front axle
PS1,PS2	Power shaft at front axle
PS3,PS4	Power shaft at rear axle

III. WORKING

90 degree steering mechanism basically helps to reduce the space required for a person to steer his vehicle. Our project of Fabrication of modified steering and drive mechanism for turning wheels through 90 degree in parallel parking, is a combination of front steer drive for normal driving and four wheels steering for 90° turning.

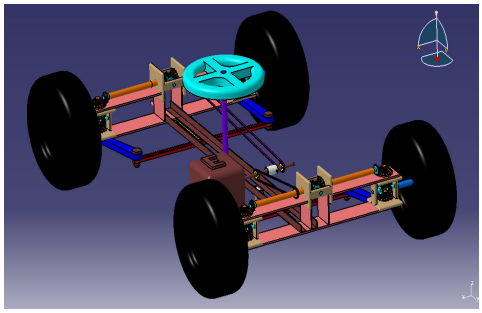

Fig. 2. 3D-model of proposed mechanism designed using CATIA V_5 software.

90° steering mechanism is especially designed to decrease turning radius for parking purposes in confined spaces. For our project we are using rack and pinions, differentials, bevel gears and other essential linkages in different arrangements as discussed below.

A. Steering mechanism

For steering of our vehicle we are using a special set of rack and pinions joined with two sets of steering arms L1, L2, L3 and L4 attached to the wheels on each sides of vehicle i.e. front and rear side.For steering of the vehicle, the steering wheel S1 will be connected through a steering shaft to steering bevel gears DS, and the shaft from DS will connect the two pinions P1 and P2.when steering wheel is rotated in clock wise direction, the motion is transferred to the front pinion shaft(during normal drive) which rotates pinion in clock wise direction due to which rack will slide towards left side and wheels will turn towards right side. Now the thickness of the pinions are sufficient to compensate the forward movement of rack. The two modes of steering are –1) Normal steering 2) 90^0 steering

In case of **normal steering** the control will be at the front side of the vehicle thus our vehicle will turn by turning the steering wheel. During normal mode hand lever which is engaging engagement pin EP1 remains in the disengaged position and steering is only provided to the front wheels.

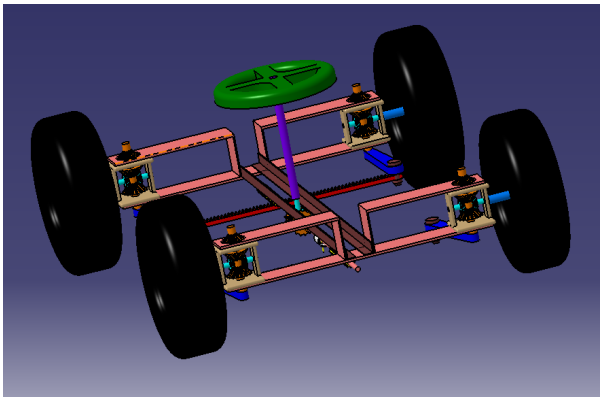

Fig. 3. Steering mechanism (Normal mode).

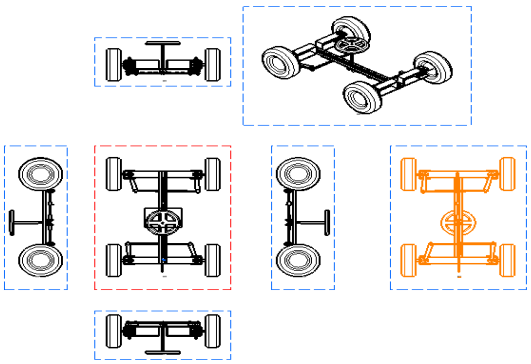

Fig. 4. Various views of Vehicle during normal steering mode.

In case of parallel parking (90^0 steering) steering system on the rear side is engaged through the engagement pin EP1and thus steering control will get transferred to all the four wheels of the vehicle to turn the vehicle at 90^0. During this operation when steering wheel will move in anti-clock wise direction it will result in anti-clockwise rotationof front pinion shaft and clock wise rotation ofrear pinion shaft due to which front rack will move towards rightward and rear rack towards leftward and wheels will be steered through 90^0. Now with the help of parallel drive mode which can be enabled by engaging the pin EP_2 power can be transmitted to front wheels along with the rear wheels and vehicle can be parked either left or right side as per .requirement.

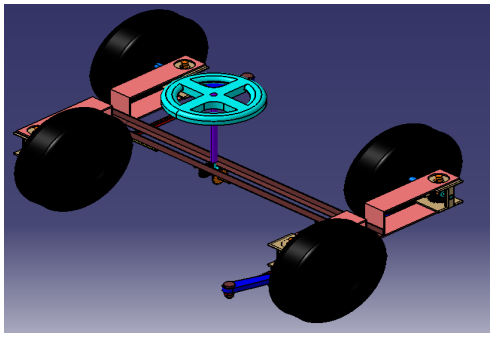

Fig 5. 90 degree turned wheels (Parking mode)

B. Power transmission mechanism

In the current work a four stroke engine is used for transmitting power to the rear axle through the chain drive. However power could easily be transmitted through actual transmission system as in cars without any major change in the proposed mechanism.

The vehicle will work as a two wheel drive during normal driving mode and four wheel driveduring parallel parking depending on the situation.

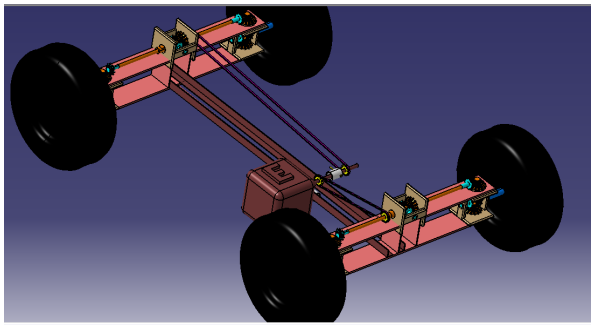

Fig. 6. Drive mechanism of the proposed Vehicle.

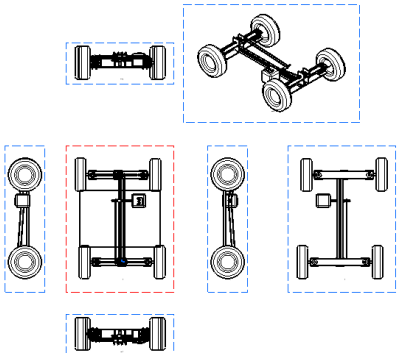

Fig. 7.Various view of proposed vehicle showing drive mechanism.

Two modes of power transmission-

- Normal driving mode
- Parallel Parking mode

In case of normal**driving mode** power is transmitted to rear axle i.e. power shaft PS4 through chain drive. Now the modified differential gear D6 attached to the power shaft PS4 reverse the direction of power shaft PS5 so that two wheels on real axle rotate in the same direction simultaneously.

In case of **parking mode** power is transmitted to all the four wheels by engaging the two sides of Power transmission mechanism by engagement pin EP2 and turning the steering wheel at maximum arc.

Modified differential assemblies- In the differential gear ring gear is removed and power is transmitted through pinion gear so when power is transmitted to axle side gear the rotation is reversed in the counter axle side gear to serve the purpose.

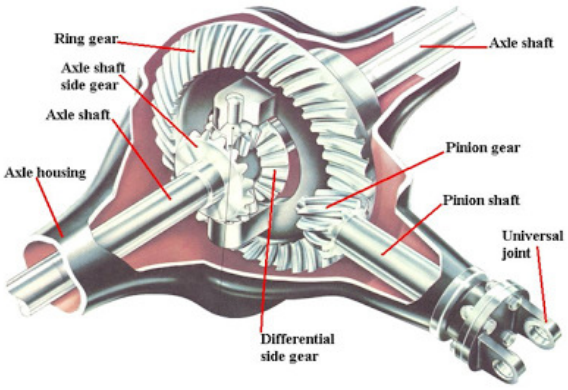

Fig. 8. Modified Differential gear Assembly.

IV. CONCLUSION

The purpose of developing this mechanism is to solve the problem of car parking. 90 degree steering mechanism helps in minimizing the space and effort required for a person to park his vehicle. The 90 degree steering mechanism made using rack and pinion and with the help of differential gears is feasible to manufacture and is easy to switch between normal mode and parallel parking mode. However, a major disadvantage here is the limitation of top speed in such mechanism due to use of differential gears. Moreover, cars can be parked very close to each other. This may save costly parking space, In congested apartment complexes where parking is limited this mechanism can be very helpful and if our vehicle got stuck to some uneven road or surface then four wheels can be engaged

to power mechanism and with this we can easily come out from that surface.

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