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DESIGN AND DEVELOPMENT OF QUDRASTEERING PROTOTYPE

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ABSTRACT

In this paper the method of design and development of a four wheel steering prototype is discussed, the prototype is a four wheeled chassis Structure, powered by electric motor. The prototype is capable to move on a surface having 30 degree slope with a velocity approximately 3kmph. The components of the system are designed and manufactured. The testing was carried out by keeping the wheel angle same, the variation of radius of curvature was noted.

Keywords- *Four-Wheel Steering, turning radius, radius of curvature, qudra wheel steering,wheel angle.*

I. INTRODUCTION

A system that uses all four wheels to steer the car is known as "Four Wheel Steering System". Turning the rear wheels in the opposite direction to the front at slow speeds can allow faster maneuvering and a much tighter turning radius. Turning the rear wheels in the same direction as those at the front at high speed allows sudden lane changes with much greater stability. Turning the rear wheels in the same direction as the front also makes parallel parking much easier. The Quadra steer steering system offers approximately 21% reduction in turning radius. It refers to a vehicle that has a steering system attached to each of the four wheels. The qudra steering system will have the components listed below.

A. Motor

Motor is a Single-phase AC motor, Power 50 watt. Speed is continuously variable from 0 to 6000 rpm. The speed of motor is variated by means of an electronic speed variator Motor is a commutator motor i.e. the current to motor is supplied by means of carbon brushes. The power input to motor is varied by changing the current supply to these brushes by the electronic speed variator; thereby the speed also is changes. Motor is foot mounted and is bolted to the motor base plate welded to the base frame of the indexer table.

B. Belt Drive

The power from the motor is supplied to the input shaft of the mechanism by means of an open belt drive. The drive comprises of the motor pulley mounted on the motor shaft, the belt and reduction pulley mounted on the input shaft.

C. Reduction Gear Box

Reduction gearbox is a worm and worm wheel gear box with gear ratio of 38:1. The gear box comprises of the following parts:

i. Input worm shaft: The input shaft is a high grade alloy steel (20MnCr5) part held in ball bearings at other end and carries the reduction pulley at one end.

ii. Worm Wheel: The worm wheel is cast iron part keyed to the worm wheel shaft.

iii. Worm wheel Shaft: The worm wheel shaft is a high grade alloy steel (EN24), held in ball bearings at either ends and carries the muff coupling to upper end. The worm wheel is fastened to the worm wheel shaft.

iv. Bearing Housing: The Bearing Housings are of structural grade steel (EN9). They hold the ball bearings to support the input worm shaft and the worm wheel shaft.

D. Universal Joints

The universal joints couple the worm gear box to the rear wheels at the either ends, they help to keep driving even when the vehicle is turning.

E. Steering mechanism

The steering mechanism comprises of the central driver link which is coupled by links to the wheel hinge and to maintain the proper angular variation the bell cranks are provided.

F. **Chassis or frame**

The frame or chassis holds entire mechanism and supports the drive train.The schematic diagram is as shown in figure 1.

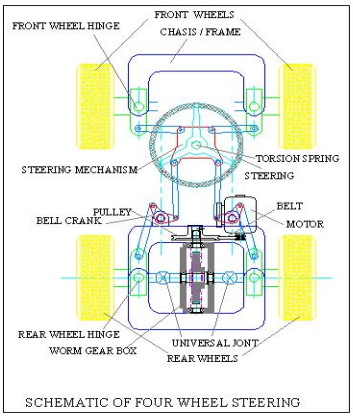

Figure 1. Four wheel steering system concept

II. OBJECTIVE

To design and manufacture a qudrasteering fulfilling following requirements:

a) Capable of negotiating a gradient of 30 degrees.

b) Weight of the vehicle 8kgs.

c) Maximum speed of the vehicle3 km/hr.

d) Diameter of tyre to be used 110 mm

A. Mechanical Scope

The main mechanical scope in the project is designing the transmission system which includes:

a) Design of chassis to fit in the mechanical and electrical components.

b) Selection of Motor with optimum power to fulfill the problem statement requirement.

c) Design of Gear box to achieve the required torque and speed of QUDRA WHEEL STEERING

d) Design of Shaft

e) Selection of Bearing

f) Selection of Belt to transmit power to the rear wheels of the vehicle.

B. Specifications

a) Length of the vehicle – 320 mm

b) Width of the vehicle – 240 mm

c) Height of the vehicle – 180 mm

d) Wheel – Wheel distance – 260 mm

e) Ground Clearance – 25 mm

III. DESIGN METHODOLOGY

Mechanical design mainly concerns with the various physical constraints and ergonomics, space requirements, arrangement of various components on the main frame of machine, ease of maintenance, scope of further improvement, height of m/c from ground etc. The Mechanical design is categorized in two parts system design and part design.

A. System Design

The system design comprises of development of the mechanism so that the given concept can perform the desired operation. The mechanism is an inversion of four bar kinematics linkage, hence the mechanism is suitably designed using Grashoff's law and the outcome is shown in the figure 2.

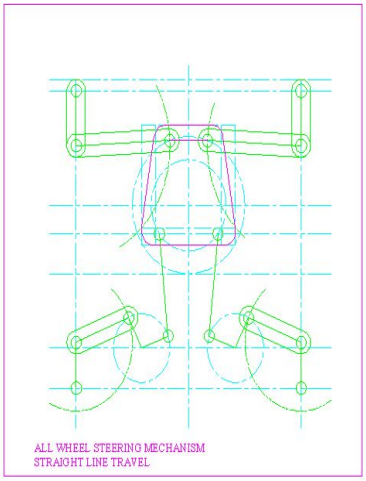

Figure 2 Steering mechanism while on a straight path

B. Part design

The standard parts like gear box, motor, timing belt, ball bearing, shafts, bearings are selected based on calculations and customised parts like input link support link central driver link, frame are designed and final dimensions are achieved.

IV. ASSEMBLY AND WORKING

The AC voltage is supplied to the motor, which is keyed to the gearbox. The motor is controlled via drive control unit, which controls the speed of the motor according to the load and the gradient. The speed and torque of 50W motor is reduced to 50rpm and 8N-m respectively. The motor carrying pulley is connected to the other pulley by belt drive mechanism to transmit power which is keyed to the gearbox. The bearings of series of 6002 and 6004 are carrying the shafts at whose splined end wheels are mounted. The linkages are connected to the central driver link to transmit the torque from rear wheels to the front wheels. The motor pulley and the reduction gear box are mounted on the indexer table. The rear wheels are mounted on the separate shaft at the end. This provides the required movement to qudra wheel steering. At slow speeds, the rear wheels are turned in the opposite direction of the front wheels. This can lessen the turning radius by approximately 20%.

At faster speeds on the highway, the rear wheels are turned in the same direction as the front wheels. This improves lane changing maneuverability and is particularly beneficial for vehicles towing a trailer.

The assembly is as shown in below figure:-

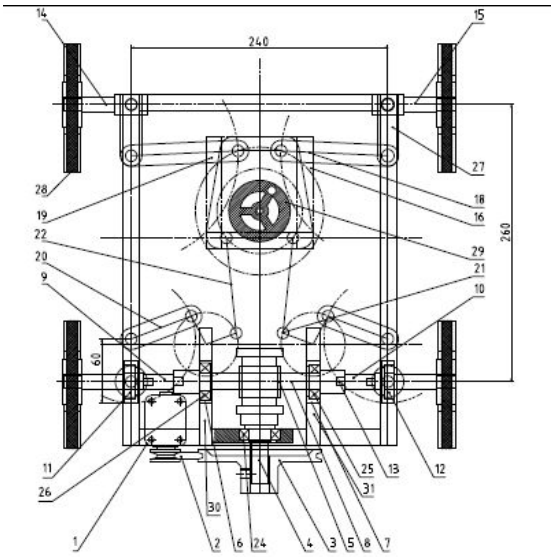

Figure 3. Assembly drawing

The parts list is as in table 1.

SR NO.	PART CODE	DESCRIPTION	QTY	MATERIAL
1.	FWS -1	MOTOR	01	STD
2.	FWS -2	BELT	01	STD
3.	FWS -3	REDUCTION PULLEY	01	MS
4.	FWS -4	WORM SHAFT	01	20MnCr5
5.	FWS -5	WORM GEAR	01	CAST IRON
6.	FWS -6	WW BRG LH HSG	01	EN9
7.	FWS -7	WW BRG LH HSG	01	EN9
8.	FWS –8	WW SHAFT	01	EN24
9.	FWS –9	LH REAR WHEEL SHAFT	01	EN24

10.	FWS –10	L H REAR WHEEL SHAFT	01	EN24
11.	FWS –11	LH RW BRG HSG	01	EN9
12.	FWS –12	RH RW BRG HSG	01	EN9
13.	FWS –13	UNIVERSAL JOINTS	02	STD
14.	FWS –14	LH FW SHAFT	01	EN9
15.	FWS –15	RH FW SHAFT	01	EN9
16.	FWS –16	STEERING PLATE	01	EN9
17.	FWS –17	REAR HINGE PLATE	02	EN9
18.	FWS –18	FW DRIVEN LINK	02	EN9
19.	FWS –19	FW DRIVERLINK	02	EN9
20.	FWS -20	RW DRIVEN LINK	02	EN9
21.	FWS -21	RW DRIVERLINK	02	EN9
22.	FWS -22	INT LINKS	02	EN9
23.	FWS -23	TORSION SPRING	01	STD
24.	FWS -24	BRG 6004ZZ	01	STD
25.	FWS -25	BRG 6002ZZ	03	STD
26.	FWS -26	BRG 6003ZZ	01	STD
27.	FWS -27	FRAME	01	MS

28.	FWS -28	WHEELS	04	STD
29.	FWS -29	STEERING	01	STD
30.	FWS -30	LH WWS BRG HSG	01	EN9
31.	FWS -31	LH WWS BRG HSG	01	EN9
32.	FWS -32	WORM BRG HSG	01	EN9

TABLE I. PART LIST

The actual prototype produced is shown in figure 4.

Figure 4. Actual Prototype

V. RESULTS AND DISCUSSION

The table 2 shows the radius of curvature for a given wheel angle for Two Wheel Steering System and the readings are plotted in figure 5.

SR. NO.	WHEEL ANGLE(DEGREE)	RADIUS OF CURVATURE(CM)
1	10	33
2	20	26
3	30	21
4	40	18

TABLE II. TWO WHEEL STEERING ANGLES

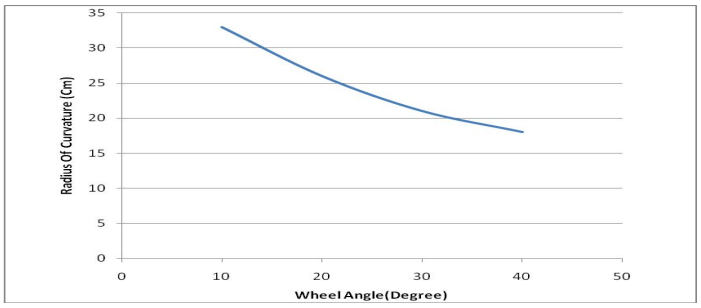

Figure 5 Radius of curvature vs wheel angle

The table 3 shows the radius of curvature for a given wheel angle for four Wheel Steering System and the readings are plotted in figure 6.

SR. NO.	WHEEL ANGLE(DEGREE)	RADIUS OF CURVATURE(CM)
1	10	27
2	20	22
3	30	17
4	40	13

TABLE III. FOUR WHEEL STEERING ANGLES

Figure 5 Radius of curvature vs wheel angle

VI. CONCLUSION

1) It is observed that when only the front wheels are steered the radius of curvature obtained is slightly higher and it is seen that the radius of curvature is inversely proportional to the steering angle.
2) When all the four wheels are steered through the same angle it is observed that the radius of curvature reduced to a greater extent and the path travelled in taking a turn is also lesser in this case.
3) There is approximately 20% reduction in the trajectory path obtained by four wheel steering system as compared to two wheel steering system, hence if a vehicle is capable of making a U-turn in a 25 feet space, Quadra steer allows the driver to do it in about 20 feet.

VII. FUTURE SCOPE

1. As the systems become more common you can expect mass production and lesser price.
2. Fully hydraulic (no direct mechanical connection between the steering wheel shaft and the steering pinion during normal operation).
3. The shape of chassis can be made more aesthetic.
4. Electronically based microprocessor can be used for steering the wheels within correct steering ratios.
5. Extensive usage of such technology with more technical researches can bring down such unfortunate incidents in anywhere in the country including hilly areas.

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