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Design and fabrication of Dual Axis Vehicle Steering Mechanism

P. Subrahmanyam[1], G. Ashok[1], M. Teja[1], M. Mohan[1], V. Manohar[1], S.Sagar[2]

[1]B.Tech, Aditya College of Engineering & Technology, Surampalem, A.P, India, 533437
[2]Assistant Professor, Aditya College of Engineering & Technology, Surampalem, A.P, India, 533437

ABSTRACT

In standard two-wheel steering vehicles, the rear wheels do not play any role in association with the steering and follow the path of the front wheels. In four wheels steering the wheels can be rotated either left or right as per the requirements. Rear wheels can be rotated in same direction as the front or in opposite direction. The four-wheel system is designed to function in 3 modes namely, in-phase rotation, counter-phase rotation and zero rotation. The steering systems are designed to give the best control designed for the vehicle. The vehicles are designed with steering control to the front wheels or in certain cases steering control is given to the rear wheels. The dual axle steering system shows the working of different motion of wheels with respect to various turning arrangements.

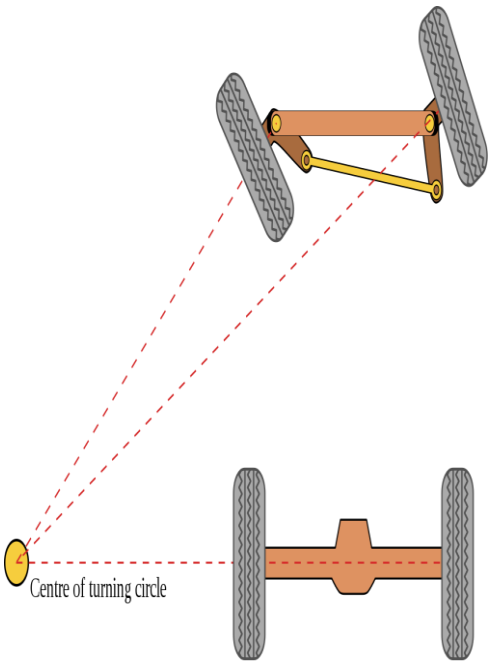
INTRODUCTION

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 (which may also be part of the collapsible steering column design), to allow it to deviate somewhat from a straight line. Other arrangements are sometimes found on different types of vehicles, for example, a tiller or rear–wheel steering. Tracked vehicles such as bulldozers and tanks usually employ differential steering — that is, the tracks are made to move at different speeds or even in opposite directions, using clutches and brakes, to bring about a change of course or direction.

Basic Geometry
Curves described by the rear wheels of a conventional automobile. While the vehicle moves with a constant speed its inner and outer rear wheels do not.

The basic aim of steering is to ensure that the wheels are pointing in the desired directions. This is typically achieved by a series of linkages, rods, pivots and gears. One of the fundamental concepts is that of caster angle – each wheel is steered with a pivot point ahead of the wheel; this makes the steering tend to be self-centring towards the direction of travel.

The steering linkages connecting the steering box and the wheels usually conforms to a variation of Ackermann steering geometry, to account for the fact that in a turn, the inner wheel is actually travelling a path of smaller radius than the outer wheel, so that the degree of toe suitable for driving in a straight path is not suitable for turns. The angle the wheels make with the vertical plane also influences steering dynamics (see camber angle) as do the tires.



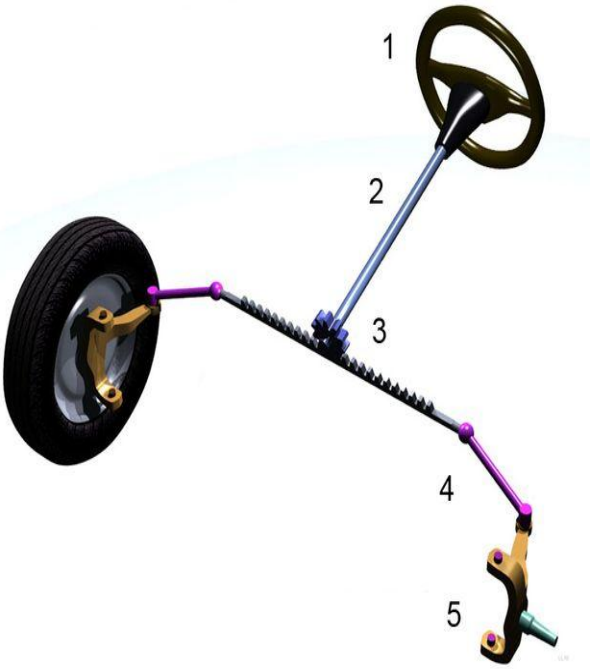


Fig: 1 Ackermann steering geometry **Fig: 2 Rack and pinion steering geometry**

Many modern cars use rack and pinion steering mechanisms, where the steering wheel turns the pinion gear; the pinion moves the rack, which is a linear gear that meshes with the pinion, converting circular motion into linear motion along the transverse axis of the car (side to side motion).

Power Steering

Power steering helps the driver of a vehicle to steer by directing some of the its power to assist in swivelling the steered road wheels about their steering axes. As vehicles have become heavier and switched to front wheel drive, particularly using negative offset geometry, along with increases in tire width and diameter, the effort needed to turn the wheels about their steering axis has increased, often to the point where major physical exertion would be needed were it not for power assistance.

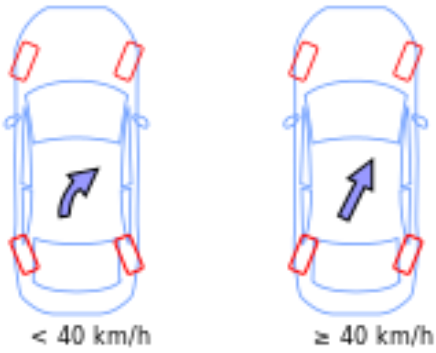


Fig: 3 Power steering

Four-wheel steering (or all-wheel steering) is a system employed by some vehicles to improve steering response, increase vehicle stability while manoeuvring at high speed, or to decrease turning radius at low speed.

LITERATURE REVIEW

Hou et al. [1] established kinematics and mathematical optimization models for the multi-axle steering system of a 10×8 multi-axle vehicle and designed a new weight function considering the probability of the steering angle. Wu and Hai [2] found the dual-axle could improve the yaw stability of a vehicle. Williams [3] extended the dual-axle model of vehicles to a multi-axle model, and analysed its steering and handing stability by establishing the differential equations of motion. Demi´c [4] utilized a linear dual-front axle yaw dynamics model to examine the

influence of structural parameters on the front wheel shimmy of a heavy vehicle.Xiang Chen et al. [5] established a 3DOF mathematical model of the multi-axle steering mechanism of a multi-axle vehicle, and analysed the causes of abnormal tire wear; Jinquan Ding and Konghui Guo [6] established a generalised system of equations to describe the fundamental handling dynamics of multi-axle vehicle including both the effects of vehicle body roll and multi-axle handling on vehicle dynamics. T Mi [7] established a 5-DOF EV shimmy model considering tire elasticity, and deduced the tyre-road constraint equation under the assumption of no slip at the leading-edge contact point. The shimmy phenomena under different structural parameters and initial conditions are simulated numerically. The simulation results show that Hopf bifurcation will occur under the condition of a certain vehicle forward speed. X.G Li [8] built a 9-DOF model considering the coupled motion of the vehicle body on the basis of the 5-DOF system, and compared the two models, and found that the 9-DOF shimmy was more likely to occur in the low-speed zone. D.G Wei [9] established a mathematical model for dual-axle steering mechanism of a multi-axle vehicle considering dry friction to study the mechanism of self-excited shimmy of multi-axle vehicle with dual-axle steering mechanism. Based on the mathematical model established by D.G Wei, W Zhang [10] analysed the influence of wheel positioning parameters on the shimmy characteristics of multi-limit cycle, and found that the influence of parameters on the shimmy characteristics of different vehicle Bridges was different.

Z.B Wang [11] designed an adaptive robust control algorithm for the electro-hydraulic power steering system of a multi-axle vehicle, including steering mechanism, valve-controlled dual hydraulic actuator and heavy-duty tire. The uncertain steering resistance moment of the tire was estimated online and the model uncertainty was compensated. The accurate tracking motion of EHPSS was realized by the establishment of a MATLAB simulation system. Q.M Zhang [12] simplifies the complex EHPSS mathematical model by using BP neural network, and conducts experimental verification of the model under no-load and load conditions, and finds that the system leakage has a great influence on the maintenance of working pressure.

METHODOLOGY

Fabrication is an important industry that involves cutting, manipulating and assembling materials to produce desired structures. And while different fabrication companies use different techniques, most rely on three basic processes: cutting, bending and assembling.

1) Cutting
The first process of fabrication is cutting. During this process, the metal fabrication company cuts one or more pieces of raw metal for use in the creation of a new metal structure or product. Whether it's steel, aluminum, iron or any other common type of metal, though, cutting metal requires special tools. Some metal fabrication companies use torches to cut metal, whereas others numerical control (CNC) machines involving lasers or water jets. When finished, the company will have clean, appropriate-sized sheets or sections of metal with which to work

2) Bending
After cutting raw metal, metal fabrication companies must bend it. Again, there are different ways to bend metal after cutting it. Some metal fabrication companies hammer the metal sheets or sections into the desired shape. Hammering can be done by hand, or it can be done using a machine (power hammering). Recently, though, many metal fabrication companies have begun using press brakes to bend their metal. This heavy industrial machine automatically presses metal sheets and sections into a specific shape when engaged. It essentially clamps the metal between a punch die, forcing the metal into the desired shape.

3) Assembling
The third and final process of metal fabrication is assembling. As the name suggests, this process involves assembling the metal sheet or sections into the desired finished product. Assembling is typically performed via welding, though other steps may be included in the process as well. In addition to welding, for example, metal fabrication companies may crimp seams, apply screws or other fasteners, and apply glue. After assembling the metal, the company will finalize the product before shipping and selling it to its customers.

Metal fabrication is a driving force behind the country's ever-growing manufacturing sector. Although there are countless machines and techniques used by metal fabrication companies, must rely on a three-step process that consists of cutting, bending and assembling. These three processes allow metal fabrication companies to transform raw metal materials into new products.

Design Consideration
Several structural design considerations should be taken into account for economical and efficient manufacturing. Many of these apply to other joining methods, and all apply to both subassemblies and the complete structure.
1. The device should be suitable for local manufacturing capabilities.
2. The attachment should employ low-cost materials and manufacturing methods.

3. It should be accessible and affordable by low-income groups, and should fulfill their basic need for mechanical power
4. It should be simple to manufacture, operate, maintain and repair.
5. It should be as multi-purpose as possible, providing power for various agricultural implements and for small machines used in rural industry.
6. It should employ locally available materials and skills. Standard steel pieces such as steel plates, iron rods, angle iron, and flat stock that are locally available should be used. Standard tools used in machine shops such as hacksaw, files, punches, taps & dies; medium duty welder; drill press; small lathe and milling machine should be adequate to fabricate the parts needed for the dual-purpose bicycle.
7. It should make use of standard parts wherever possible.
8. The device should adapt easily No permanent structural modification should be made
9. Excessive weight should be avoided, as durability is a prime consideration.

Design Drawing and Pictures

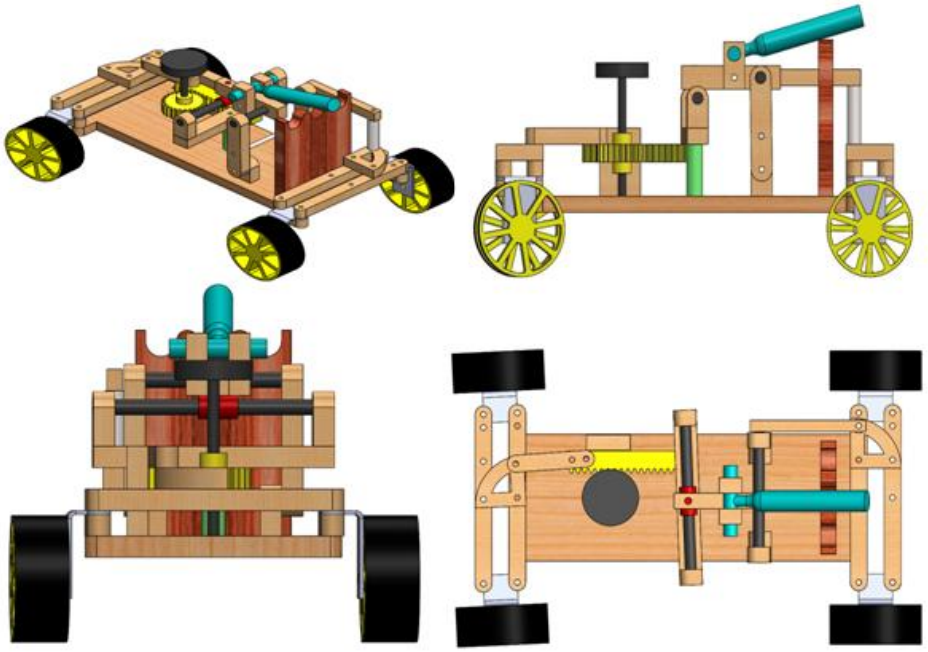


Fig: 4 Design and fabrication

Fabrication Process

Metal fabrication is taking a raw material, typically sheets of metaland other flat materials, through a series of processes to create a finished end product. Virtually every industry relies on metal fabrication to operate efficiently, create the tools they need, develop products, etc. As you can see, it is a very broad industry that helps the entire world run.

Fabrication is the process of manufacturing sheet metal and other flat materials to make them conform to specific shapes. The process starts with sheet metal around a quarter of an inch thick or less. At this thickness, the sheet metal and other flat materials is pliable enough to assume different shapes. Using this metal, fabricators alter the sheet to create a specific shape. This takes place through cutting, stamping, shaping, folding and welding. Another related practice is custom fabrication, meaning the creation of new custom parts using novel combinations of these processes.

WORKING RESULTS

In four wheels steering the wheels can be rotated either left or right as per the requirements. Rear wheels can be rotated in same direction as the front or in opposite direction. The four-wheel system is designed to function in 3 modes namely, in-phase rotation, counter-phase rotation and zero rotation.

The steering systems are designed to give the best control designed for the vehicle. The vehicles are designed with steering control to the front wheels or in certain cases steering control is given to the rear wheels. The dual axle steering system shows the working of different motion of wheels with respect to various turning arrangements. The machine consists of 3 different steering arrangements i.e., neutral phase, negative phase & positive phase.

In neutral phase only the front wheels either runs in the right or left direction and the rear wheel are the followers of the front wheels. In the negative phase, both front and rear axles move in the opposite direction relative to each other. In the positive phase, both the axle front and rear move in the same direction relative to each other. Here we need to lift the shifter and place into the respective slot for the required motion.

CONCLUSIONS

The project carried out made an impressing task in the field of automobile industries. It is very useful for driver while driving the vehicle.

The project is based on Dual Axis Vehicle Steering Mechanism where due to the awareness of safety, four-wheel steering vehicles are being used increasingly, since they are also known for their high performance and stability.

In standard two-wheel steering vehicles, the rear wheels do not play any role in association with the steering and follow the path of the front wheels. In four wheels steering the wheels can be rotated either left or right as per the requirements. Rear wheels can be rotated in same direction as the front or in opposite direction. The four-wheel system is designed to function in 3 modes namely, in-phase rotation, counter-phase rotation and zero rotation.

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This project has also reduced the cost involved in the concern. Project has been designed to perform the entire requirement task which has also been provided.

FUTURE SCOPE

Having studied how 4WS has an effect on the vehicle's stability and driver manoeuvrability, we now look at what the future will present us with. The successful implementation of 4 Wheel Steering using mechanical linkages & single actuator will result in the development of a vehicle with maximum driver manoeuvrability, uncompressed static stability, front and rear tracking, vehicular stability at high-speed lane changing, smaller turning radius and improved parking assistance. Furthermore, the following system does not limit itself to the benchmark used in this project, but can be implemented over a wide range of automobiles, typically from hatchbacks to trucks. This coupled with an overhead cost just shy of Rs. 15,000 provides one of the most economical steering systems for improved maneuverability and drivers‟ ease of access. With concepts such as ZERO TURN‖ drive as used in Tata Pixel and 360o Turning used in Jeep Hurricane, when added to this system, it will further improve manoeuvrability and driver's ease of access.

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