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Development and Fabrication of 90 Degree Quadra Wheel Steering System

Abhinandan B S¹, Anish H J¹, Karthik A M¹, Karthik M V¹, Dr. Arun C Dixit²

Students of ME, Vidyavardhaka College of Engineering, Mysuru, India¹

Professor of ME Department, Vidyavardhaka College of Engineering, Mysuru, India²

ABSTRACT: Nowadays, most existing vehicles are using the two wheel steering system to control the movement of the vehicle whether it is front wheel drive, rear wheel drive or all wheel drive. But 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 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 consist 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

KEYWORDS: Steering, All wheel drive, Dual Axle, Stability, Vehicle

I. INTRODUCTION

The development and fabrication of a 90-degree quadra wheel steering system entail a detailed engineering process for enhanced vehicle manoeuvrability. Beginning with a comprehensive design phase, the system incorporates precise actuators, sensors, and a sophisticated control algorithm to independently manage the 90degree steering angles for all four wheels. High-quality materials are chosen for mechanical components, and a robust control system is developed with real-time feedback integration. The chassis is modified to accommodate steering components without compromising structural integrity. Specialized steering assemblies with integrated actuators are fabricated, and sensors are installed for accurate data collection on vehicle dynamics. A reliable power supply system is designed, and extensive quality checks are conducted throughout the fabrication process. The concept of four wheel steering has existed since the 1980s with car manufacturers experimenting with rear wheel steering mechanisms that provided only a few degrees of movement primarily for improving stability and handling; however, advancing suspension and steering gear design in the 1990s enabled research focused specifically on dramatically increasing steering articulation. This led to the first 90 degree quadra steer prototypes in the early 2000s targeted at specialized vehicles requiring exceptional manoeuvrability like military transports operating off-road. Wider adoption in recreational vehicles started in the 2010s once fabrication challenges around component durability and precision steering capabilities were overcome. The complex task building aquadra system that turns all four wheels up to 90 degrees requires custom fabricated tie rod ends, steering linkages and differential gears capable of extreme articulation without binding or failure; additionally, housings, drive shafts, suspension parts and the steering columns itself must be uniquely designed to allow this expanded range of motion. Significant engineering expertise is needed in the fabrication process to construct rugged systems that provide precision steering feel vehicle's full operating range. Following assembly, extensive calibrstion and testing must still validate safe and reliable real world performance before these cutting edge quadra steering systems are ready for sale to consumers.

II. METHODOLOGY

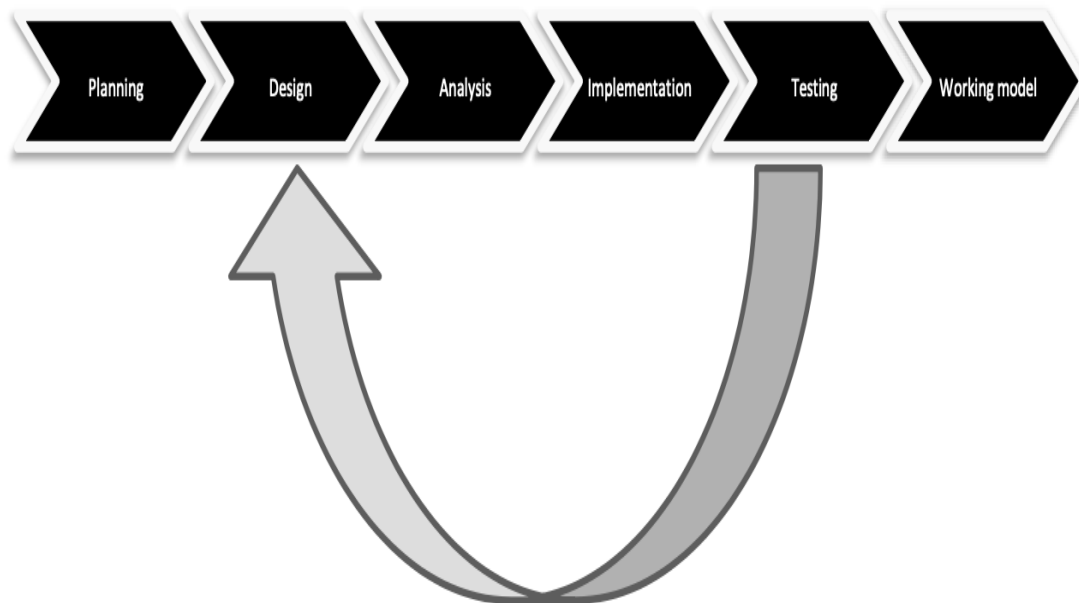


Figure 1: Objective and Scope of the Project

Our main objective is to create a prototype model of mechanism of quadra wheel steering system.

It will consist of a rack and pinion arrangement of steering system on a wooden base frame.

Wooden Links and joints are connected through nuts and bolts. Quadra-wheel steering system will be designed to function in 3 modes namely, in-phase rotation, counter phase rotation and zero rotation.

III. LITERATURE REVIEW

[1] Dr. S. D. Bhisare and colleagues The car business is one of the most important for a country's development. The enormous and varied transportation industry in India has its own set of problems. These challenges might be solved by fusing customer-focused strategy with energy-efficient technological advancements. It should always be extremely comfortable for the driver to operate the car's advanced features. Stability is the primary cause of an automobile exceeding its cruising speed. The possibility of instability increases when a car with a four-wheel navigation system accelerates and its back wheels rotate in the opposite direction of the forward-facing wheels. Rear wheels follow the same path as the forward-facing wheels during all-wheel steering system fine-tuning to avoid this.

[2] Vasamsetti Subramaniyam et al. In this project work, an attempt was made to provide a suitable tiny automotive model in order to address the parking and traffic challenges that beset urban mobility. This project involves correctly altering an existing hatchback car's chassis. The single box part consists of two seats with two doors, a luggage boot, and trimmed corners. Weight loss increased mileage and reduced production costs. A connection on each wheel enables it to steer around a single instantaneous center. This design gave the vehicle a relatively small turning radius of approximately 2.9 meters, which made it exceedingly maneuverable. The wheel bearings and tire life are extended by this method.

[3] Venkatesh Reddy and associates A new environmentally friendly car that enables wheelchair users to move independently in low-emission vehicles would definitely be an improvement to current system. Finding a green vehicle is necessary to accomplish this; an electric automobile that can turn 90 degrees easily would be a good choice. The contemporary car is incapable of steering at a ninety-degree angle. These cars are capable of helping those with

impairments. In an attempt to implement this idea, numerous studies have been carried out in this field; nevertheless, this has not yet occurred. The idea is to use electric motors on any two diagonal wheels in a counterphase system. The mechanism can only run slowly. One advantage of this technique is that it requires less.

[4] Gautam Pushkin and others, Selectable all-wheel steering is a relatively recent technology that improves maneuverability in cars, trucks, and trailers. All-wheel steering is frequently used for parking and low-speed maneuvers, even though this type of steering system allows for steering on both two and four wheels. "Selectable all wheel steering" refers to the enhanced form of aws (all wheel steering). The four wheels can be engaged and withdrawn in this manner based on the driver's demands. This has advantages for both two-wheel and four-wheel steer. It can therefore be utilized as all-wheel steer in tight turns and as front wheel steer in lengthy straightaways. There are various configurations of mechanically operated saws that don't require significant modifications.

[5] Kumar K. Vinoth et al. The objective of our research is to create a multimode steering system that will reduce an automobile's over-turning radius while it is being driven (4ws). The front wheels are turned by the driver using a hand-operated steering wheel that is positioned in front of them. One feature that allows it to stray from a straight line in accordance with the road is the foldable steering column with a universal joint. The multimode steering system allows for the easy switching between two steering modes as necessary, allowing for a compact turning radius both on and off the road and easier parking in crowded situations.

[6] Gohil Bhavesh K. and others For cars, we now use a two-wheel steering system, which means that the back wheels are inert and do not provide steering. In a four-wheel steering system, both the front and rear wheels may steer. The Maruti-800 car is chosen as a model in this instance. We have developed an optimized four-wheel steering system to implement a mechanism that can change the in-phase and counter-phase steering of the rear wheels depending on the turning and lane-changing conditions with respect to the front wheels, thereby improving the sedan's maneuverability in relation to its speed.

[7] Saxena Sachin et al. This study focuses on the 4-wheel steering mechanism, as opposed to the 2-wheel steering found in typical Indian cars. A 4-wheel drive is not the same as a 4-wheel steering system (where power is applied to all four wheels instead of just two). A 4-wheel steering system is better than a 2-wheel steering system. There is a reduction in both the turning space and turning radius. Additionally, it enables lane changes while driving, even at fast speeds. Research for this work is currently underway in an Egyptian university. In this project, we want to build an electric car with rotating wheels to address the problem of parking in large cities.

[8] Biagio Borretti, engineer et al. This article discusses the dana intelligent twin steering system for mobile vehicles with two steering axles, or four steering wheels. In most modern four-wheel-steering vehicles, the two steering cylinders are linked in series via a hydraulic system. This type of connection discloses certain limitations on the power that may be employed, steering comfort, and the capacity to support complex jobs. Dana invented this type of hydraulic arrangement and also made it feasible to separate the front and rear axles. Thus, the rear axle adds more advanced steering characteristics and improves the steering system's performance under the electronic control of its valve block.

[9] Er. Amitesh Kumar et al., Conventional steering mechanisms use Ackerman or Davis steering systems. One disadvantage of these systems is their ability to produce the shortest turning radius possible by steering motion. The difficulty involved in using traditional steering techniques is eliminated when a four-wheel steering system is utilized. This method rotates the wheels that are attached to the front and rear axles counter-clockwise. The left half of the vehicle's wheels turn in one way, and the right half of the vehicle's wheels turn in the opposite direction. The car can do a full 360-degree turn with these wheels without losing its current position. For the vehicle, there is no turning radius. This facilitates driving the car.

[10] Soni Aayush et al. Currently, all cars have two-wheel steering, regardless of whether they are front-wheel, rear-wheel, or all-wheel drive. Both the front and back wheels are guided by a four-wheel steering system called "quadra steering" based on the vehicle's speed and the available turning space. The vehicle's stability and performance are enhanced by this technology. The performance of the quadra steering system at low, medium, and high speeds has been considered in this paper. For parking and low speed conditions, the rear wheels are turned in the opposite way from the front wheels, and for medium and high speed conditions, the front and rear wheels are spun in the same direction. As a result, the vehicle has a much smaller turning radius and is steadier.

[11] Murali Vishnu and others, It is a well-established fact that most cars have a two-wheel steering mechanism as their main handling system. Two-wheel steering cars, however, are less efficient than four-wheel steering cars, according to study. Cars can be equipped with a four-wheel steering system to improve the vehicle's steering reaction and stability at a given speed, as well as to effectively reduce the turning radius at low speeds. Those that drive all-terrain vehicles think off-roading provides a more expansive and promising platform. It stands to reason that equipping an ATV with four-wheel steering would increase its maneuverability over rough terrain.

[12] Khot Aditya et al. This aims to give the zero turn vehicles an alternative way. If we just modified the wheel system instead of the entire steering system, the car would be in better practical shape. In actuality, the zero turn vehicle technology is employed by the Jeep Hurricane. The steering system was more complex because it was directly connected to the wheel positioning system. We suggest a unique zero turning four wheel mechanism that is driven by mechanical links to solve this problem. This means that the wheel positioning mechanism will be controlled by the 12 volt DC geared motor located at the center of the wheel. and as a result of that notion, changing the wheel's position is easy. The vehicle has 360-degree rotation capability.

[13] Karthik T. and others In a typical two-wheel steering arrangement, the back wheels are constantly facing forward and do not actively steer the car. A four-wheel steering system that can be adjusted for both high and low speeds does involve the rear wheels actively contributing to steering. Typically, production cars are designed to understeer and are rarely oversteered. If a car could automatically correct understeer or oversteer, the driver would benefit from almost neutral steering under different driving conditions. A sedan's wider track and longer wheelbase make it more difficult to drive in situations like parking, low-speed curves, and crowded city streets. A mechanism with a lower turning radius is therefore required.

[14] Bobade, Suraj, and others, Nowadays, due to modern development and economic progress, there are more cars on the road. The growing number of people owning cars has made parking a major problem in most parts of the nation. Standard front wheel steering systems do not cause the rear wheel to turn in the direction of the curve. For example, low speed cornering, parking, and driving in urban situations with dense traffic in limited spaces would be very challenging for high speed lane changes because of the vehicle's enlarged wheelbase and track width, which account for high inertia and traction. Two-wheel steering is hence less successful. This calls for the requirement for a mechanism with a smaller turning radius.

[15] Mr. Bevinkatti Krishna and others, A four wheel steering system is sometimes known as a quadra steering system. Both of the wheels in this paper can be steered in accordance with the other vehicle's speed and the available turning space. Because full-size cars can quadra steer, they are easier to handle at low speeds. However, driving at faster speeds improves handling, control, and stability. Production-built cars rarely oversteer and commonly understeer. If an automobile could self-correct an under steer overseer problem, the driver would benefit from nearly neutral steering in a variety of situations. Design engineers in the automotive industry work very hard to use four wheel systems to attain near-neutral steering. Construction and agricultural machines, as well as off-road vehicles like forklifts, use this technology.

[16] P Baskara Sethupathi et al. state that four-wheel steering is used in light motor vehicles to improve maneuverability. The rear wheels of traditional two-wheel steering vehicles go in the same direction as the front wheels and do not assist in steering. Depending on the circumstance, the four-wheel steering system allows the wheels to be turned either left or right. The rear wheels have the option of rotating in unison with the front wheels or simultaneously with the other wheels. The four-wheel system is designed to function in three different modes: in-phase, counter-phase, and zero. The user can choose and switch between modes by just pressing the lever. A specially made selector box's rear is connected to the front rack via a linkage, and the selector.

[17] According to Arun Singh et al., a car's two-wheel steering system is still largely responsible for its movement in the present era, regardless of whether it has front-wheel drive, rear-wheel drive, or all-wheel drive. However, as a result of growing safety consciousness and their excellent performance and stability, four-wheel steering cars are being used more commonly. This paper evaluates the performance of a four-wheel-steered vehicle model that is ideally controlled during a lane change maneuver. Low speed maneuvers, medium speed maneuvers, and high speed maneuvers are these circumstances. Four-wheel steering is used to steer the rear wheels. Sharper turns are made possible by the rear wheels steering in the opposite direction as the front wheels when parking and doing low-speed maneuvers. The back wheels have the same steering.

[18] Suresh Kumar P and others, One of the most important industries for a country's development is the automobile industry. The large and varied transportation industry in India has its own set of problems. These challenges might be met by fusing customer-focused strategy with energy-efficient technological advancements. While using the cutting-edge features of the vehicle, the driver should always feel quite comfortable. Steadiness is the primary cause of an automobile exceeding its cruising speed. The possibility of instability is heightened when a car with a four-wheel navigation system accelerates and its back wheels rotate in the opposite direction of the forward-facing wheels. To avoid this instability, the rear wheels go in the same direction as the forward-facing wheels while the all-wheel steering system is fine-tuned.

[19] Mohd Asim Shoeb Asrail and others, A quadra steering system, sometimes referred to as a four wheel steering system, reduces turning radius by enabling steering of both the front and rear wheels. It is possible to steer all the wheels in different configurations. However, the project will make use of a rack and pinion (spur gear) configuration. The front and rear sides of the frame each have two steering racks attached to them. The two spindle-and-pinion steering racks are connected by the rack. The front and rear steering rack pinions should mesh as a result of the rack's placement. This results in the transmission of motion from the front steering rack to the rear steering rack. As a result, all wheels steer simultaneously.

[20] Bhishikar Saket and others, In a typical two-wheel steering arrangement, the back wheels are constantly facing forward and do not actively steer the car. A four-wheel steering system that can be adjusted for both high and low speeds does involve the rear wheels actively contributing to steering. Typically, production cars are designed to understeer and are rarely oversteered. If a car could automatically correct understeer or oversteer, the driver would benefit from almost neutral steering under different driving conditions. A sedan's wider track and longer wheelbase make it more difficult to drive in situations like parking, low-speed curves, and crowded city streets. A process that results in a decreased turning radius is therefore necessary.

IV. CONCLUSION AND FUTURE WORK

In conclusion, the successful development of a 90-degree quadra steer mechanism posed significant design challenges, but the project team innovatively overcame them. The dual knuckle arm configuration, along with FEA-optimized components, ensures a 90-degree steering angle at all four wheels, addressing key requirements for strength, durability, and effective vehicle handling. The breakthrough prototype passed robustness tests, demonstrating reliability in extreme steering angles. Despite promising results, ongoing refinement is necessary, focusing on reducing complexity, enhancing component strength, minimizing weight, and improving steering feel. Noise, vibration, and harshness must be minimized, and additional prototype iterations and analysis work are recommended. To make the system production-ready, extensive validation and qualification testing are required to meet safety and reliability standards. Collaboration with automotive steering/suspension suppliers is proposed to expedite bringing this technology to market. In summary, the quadra steer mechanism, though in need of refinement, serves as a powerful proof of concept. Collaboration with industry partners is encouraged to further develop this revolutionary steering technology. The achievement opens the door for passenger cars with unprecedented manoeuvrability, promising a transformation in how vehicles handle turns, evasive manoeuvres, parking, and more. The project team is ready to collaborate for ongoing innovation in quadrilateral steering, aligning with industry needs for agile four-wheel steering in tomorrow's vehicles.

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