International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

IMPLEMENTATION OF A FOUR-WHEEL STEERING SYSTEM

Prof A. K. Battu[1*], *Yogendra Chavan*[2]*, *Vaishnavi Gunale*[3*], *Prathamesh Lolage*[4]*, *Chetan Pathade*[5*]

[1*]**Associate Professor Faculty of Mechanical Engineering, D Y Patil College of Engineering, Savitribai Phule Pune University, Pune, Maharashtra, India**

[2*3*4*5]***Student, of Mechanical Engineering, D Y Patil College of Engineering, Savitribai Phule Pune**
University, Pune, Maharashtra, India

ABSTRACT:

This project aims to evaluate the effectiveness of a four-wheel steering system in cars, which offers improved control and maneuverability. Unlike traditional two-wheel steering vehicles where the rear wheels simply follow the front wheels, a four-wheel steering system allows the rear wheels to turn in the same or opposite direction as the front wheels. This enhances vehicle control during parking and low-speed maneuvers, reducing the turning radius. The convertible system offers two steering modes, making it easier to navigate tight spaces and off-road terrain. The system employs spur and bevel gears, with the bevel gear mechanism engaging when the mode is changed, minimizing the turning radius. CAD software is used to design the system, which is then analyzed using ANSYS software for further evaluation.

KEYWORDS: ANSYS, SolidWorks, Drafting, Gyroscope Sensors, Arduino.

INTRODUCTION:

The rising road traffic demands innovative vehicle handling mechanisms. One solution is the Two-Mode Interchangeable Four Wheel directing, which allows the rear wheels to turn independently from the front wheels. This technology improves control, especially during parking and turning. Our research aims to enhance the steering system by reducing the turning radius by up to 45 to 55% and enabling sideways movement for easier parking. Four-wheel steering (4WS) is another method that can improve handling stability and reduce the turning radius by steering the front and rear wheels separately. Our capstone design project focuses on developing a mechatronic control system to enhance the vehicle's handling performance in challenging steering conditions.

PROBLEM STATEMENT:

One common issue encountered while steering is experiencing difficulty when turning the wheel, particularly at lower speeds or while stationary. This challenge may arise from various factors such as power steering problems, low fluid levels, fluid leaks, or worn-out components. To address this concern, our project guarantees improved steering performance at any given session or location. Our reliable mechanism ensures a connected system that enhances driver comfort and responsiveness without resorting to plagiarism.

WORKING APPROACH:

Step 1-

Through an extensive literature survey, we collected relevant research papers on the subject and gained knowledge about automatic four-wheel steering and seat balancing systems in electric vehicles (EVs). These systems aim to enhance vehicle maneuverability, stability, and passenger comfort by allowing all four wheels to actively turn and dynamically adjust the seat position based on various factors.

Step 2-

Following the literature survey, the necessary components for seat balancing were determined based on the gathered insights.

Step 3-

Once the components were finalized, the 3D modeling and drafting phase will commence utilizing CAD software such as SolidWorks and CATIA.

Step 4-

Following the completion of 3D modeling and drafting, the components will be fabricated through manufacturing processes, and subsequently, they will be assembled together to create the seat balancing system.

Step 5-

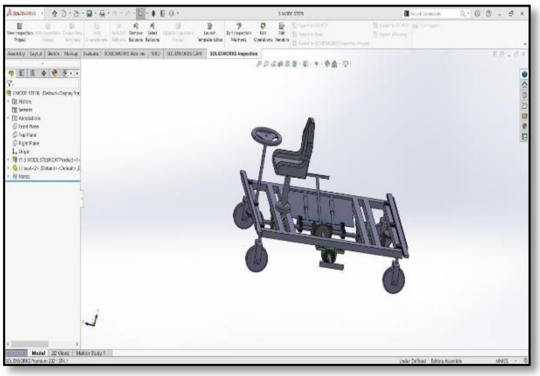
Following assembly, rigorous testing will be conducted to obtain results and draw conclusive findings.

WORKING PRINCIPLE:

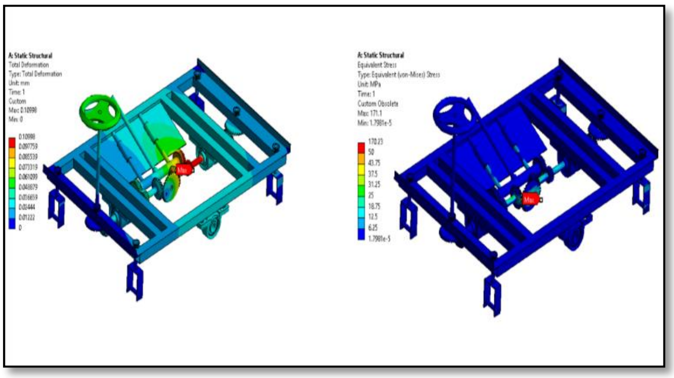
The steering arrangement, bevel gears, lock nuts, and spur gears make up the system. The steering function resumes in its normal state when the lock nut has been released. Only the front wheels are steering. However, a different mode can be employed when the lock nut is inserted. The spur gear engages when the gear arrangement moves into one position. The rear wheel steers in an opposite direction from the one on the front because of the spur gear's arrangement. As a result, second-mode steering is produced.

The two modes are,

1. Normal Mode
2. Reduced Turning Radius Mode



3D CAD MODEL



ANALYSIS OF FRAME IN ANSYS

CALCULATIONS:

1. ***Bevel gear***

I = gear ratio

Z_p= number of teeth on driving gear=20

Z_g= number of gears on driven gear=40

Shaft angle ()=90

Module (m)=3

Pressure angle(α)=20

Spiral angle (β)= 21.5^0

Norma pressure angle(αn)=18.70^0

Dp=Diameter of driving gear=40mm

Dg= Diameter of driven gear=80mm

Tangential force (Ft)=2000T/Dp=100

Axial force (Fa)=Ft*tan (β)=39.4

Radial force (Fr)=Ft tan(αn)/cos(β)=36.4

Input torque(T1) =2

Output torque(T2) =Ft*Dg/2000=4

$I = Z_p / Z_g$

I = 20/40

I=0.5

2. SPUR GEAR

I = gear ratio

Zp= number of teeth on driving gear=12

Zg= number of gears on driven gear=24

Module (m)=3

Pressure angle(α)=20

Spiral angle (β)= 0

Dp=Diameter of driving gear=40

D_g= Diameter of driven gear=80

Tangential force (Ft)=2000T/Dp=100

Axial force (Fa)=0

Radial force (Fr)=Ft tan(α)=36.4

Input torque(T1) =2

Output torque(T2) =Ft*Dg/2000=4

I = Zp / Zg

I = 12/24

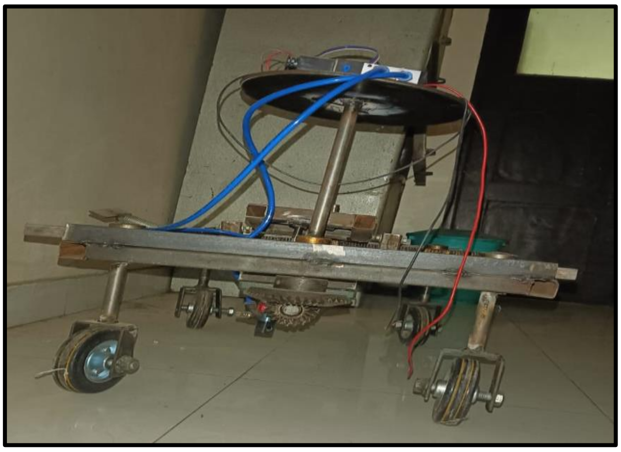
I=0.5

TESTING RESULTS AND DISCUSSIONS:

In the virtual design process, a 3D CAD model of the frame is created for the four-wheel steering mechanism. Solid modeling offers parametric capabilities, allowing easy modification of parameters, editing, and saving at any stage. This flexibility enables swift changes without starting from scratch. To test the CAD model, ANSYS software is used for static structural analysis. This analysis examines displacements, stresses, strains, and forces caused by loads that have minimal impact on inertia and damping effects.

Where we get outcomes:
Total deformation is 0.10998 mm.
Equivalent Stress: Maximum: 171.1 MPA
Minimum: 1.7981 MPA
We discovered after getting this result that all the parameters fall within the acceptable range, thus we proceed to the model's production stage.

ACTUAL WORKING MODEL:



CONCLUSION:

This innovative project ensures exceptional steering performance in any situation or location, thanks to its interconnected mechanism, which guarantees reliability and driver comfort. With its ability to effortlessly navigate tight parking spaces and execute precise turns, including U-turns, this technology provides unparalleled convenience. Four-wheel steering enables vehicles to achieve a significantly reduced turning radius, enhancing handling stability and active safety. Moreover, it offers benefits such as improved straight-line stability, lane switching, and maneuverability at low speeds. As this technology gains popularity, an increasing number of new vehicles are expected to incorporate four-wheel steering. Detailed descriptions, diagrams, and sequential presentation of the original device's components enhance comprehension and facilitate fabrication.

REFERENCES:

1. Kuwar, V., Setia, S., Pachhapurkar, N., Pawar, P. et al., "A Novel Method for Active Vibration Control of Steering Wheel," SAE Technical Paper 2019-26-0180, 2019, https://doi.org/10.4271/2019-26-0180.
2. Nicolae URSU-FISCHER, Diana Loana POPESCU, “A Geometric for Optimize The Ackerman-Type Steering Mechanism”, ACTA TECHNICA NAPOCENSIS, Vol 64, No 2 (2001)
3. Kulkarni, K. and Thyagarajan, R., "Optimizing the Effects of Body Attachment Stiffness on Steering Column In-Vehicle Modes," SAE Technical Paper 2001-01-0041, 2001, https://doi.org/10.4271/2001-01-0041.
4. M. Veneri, M. Massaro, “The effect of Ackermann steering on the performance of race cars”, Volume 59, Issue 6, Pages 907-927
5. John, Svensson, “Design of portable steering wheel angle system”,
6. Massimiliano Gobbi, Francesco Comolli, Masatoshi Hada, Gianpiero Mastinu, “An instrumented steering wheel for driver model development”, https://doi.org/10.1016/j.mechatronics.2019.102285
7. M.M. Topaç* , A. Kaplan , B. Kuleli , U. Deryal, “ Design of a Multi-Axle Steering Mechanism for a Special Purpose Vehicle: Kinematic Design and Optimization”
8. Rithvik M S, Hari Vignesh B, Kavin S K, Yazharasu A, “FOUR WHEEL THREE MODE STEERING SYSTEM”, Volume: 5 Issue: 3, Page 762-764