Modeling and simulation the resistance torque for specific wheel alignment in the Electric Power Steering system by using Matlab/Simulink and its application.

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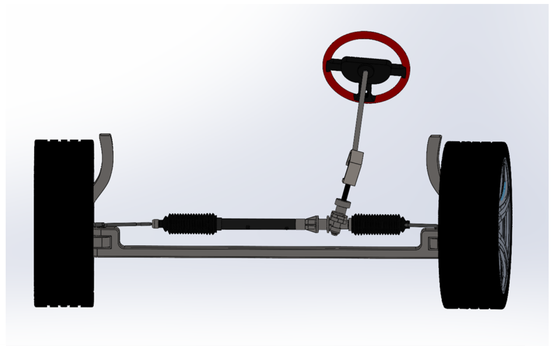


1 Abstract:

Vehicle steering dynamics is an essential topic in development of safety driving systems. These complex and integrated control units require precise information about vehicle steering dynamics. In the term of interaction between tire forces and road surface, we are going to primarily focus on the total resistance moment which is the factor torque that urges the tires to steer. This resistance moment that causes this combine with the wheel alignment will be described in below when considering the mass of vehicle, lateral force generation, longitudinal force generation and normal force generation. Through this Capstone project, this torque will be fully showed with the theoretically corresponding equations and combine with the model diagrams by using Matlab/Simulink software.

2 Objectives, scope and mission summary:

- Objective: focus on building mathematical models and simulations of the magnitude of this resistance torque under different driving conditions.
- Scope: only investigate the effects wheel alignment and specific factor on the total resistance torque.
- Mission summary: base on this scope, I will divide the whole objective into 2 main missions: The first one is get fully understanding knowledge about the resistance torque between the tire force and road surface in steering mechanism especially in the EPS system and the second one is how wheel alignment and other factors can affect to the resistance torque in steering mechanism especially in the EPS system and simulate by using Matlab/Simulink software.

3 Specific tire forces, wheel alignment and Ackerman condition:

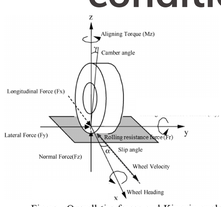


Figure : Overall tire forces and Kingpin angle

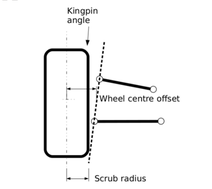


Figure : Kingpin angle and its scrub radius

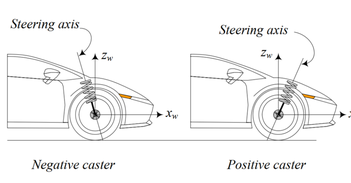


Figure: Overall in Caster angle

$$cot\delta_o - cot\delta_i = \frac{w}{l}$$

$$\delta_i > \delta_o$$

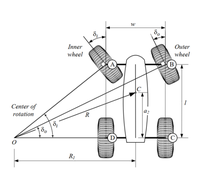
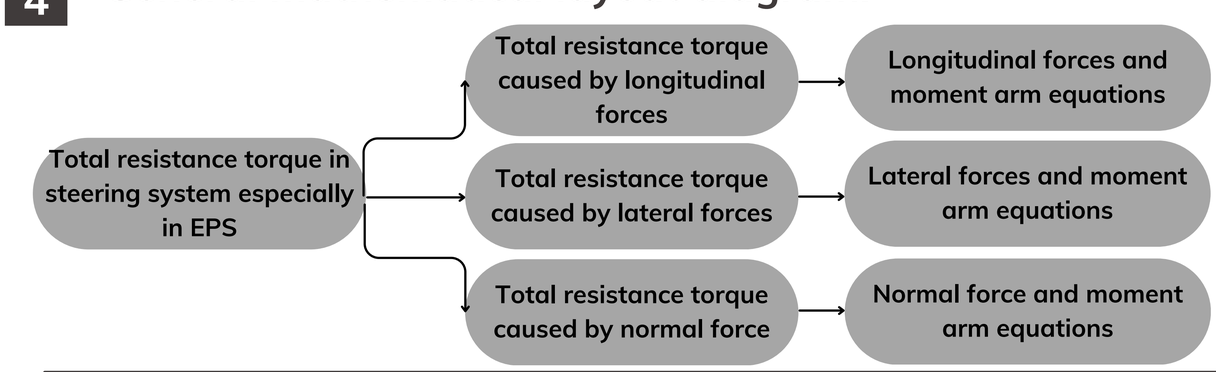


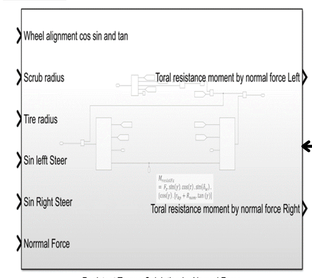
Figure : Ackerman condition

4 General mathematical layout diagram:

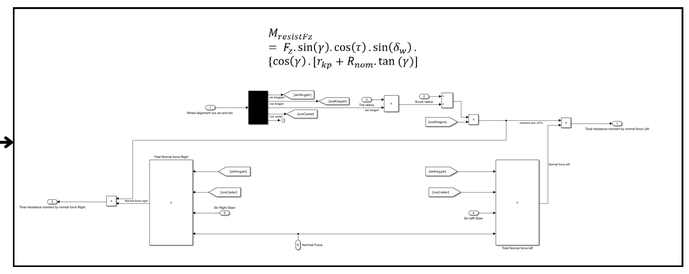


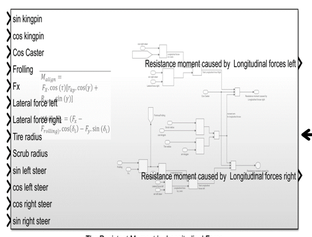
5 Calculation process diagram:

6 Matlab/Simulink modeling:

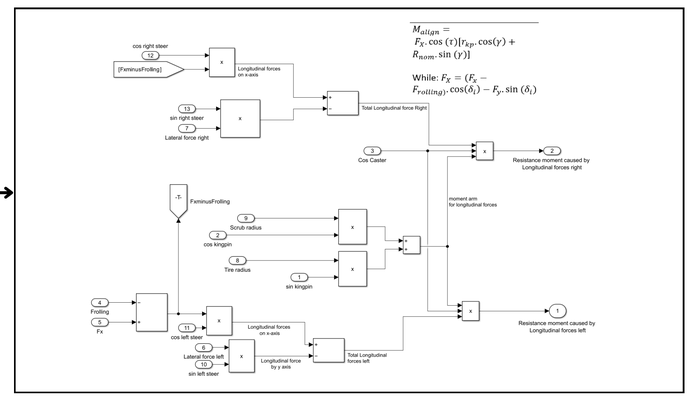


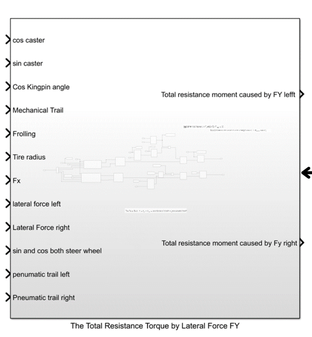
Resistant Torque Calulation by Normal Force



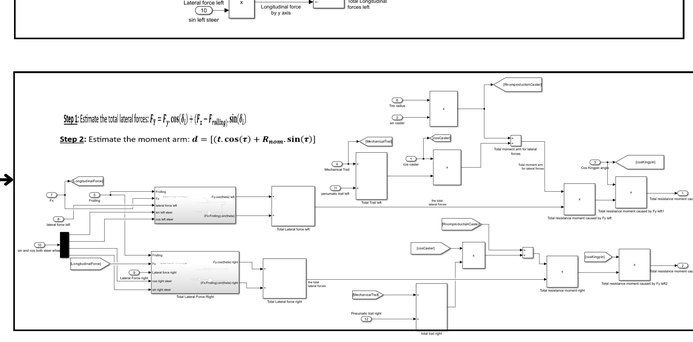


The Resistant Moment by Longitudinal Force

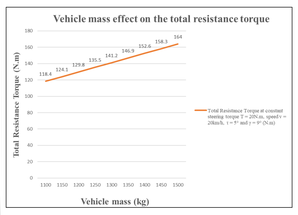


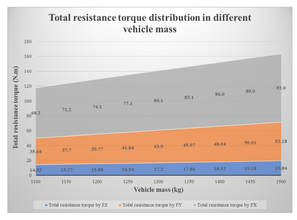


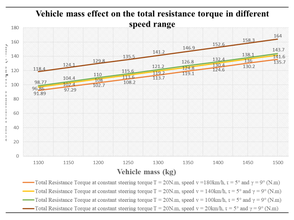
The Total Resistance Torque by Lateral Force FY



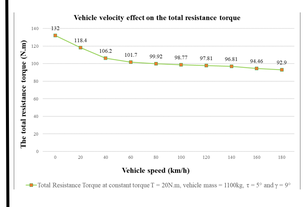
7 Specific results:

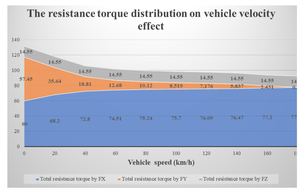


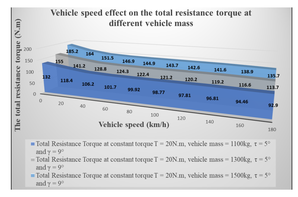




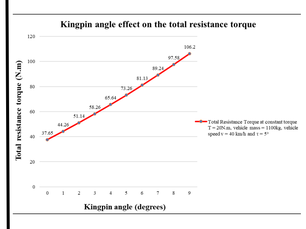
Changing in vehicle mass

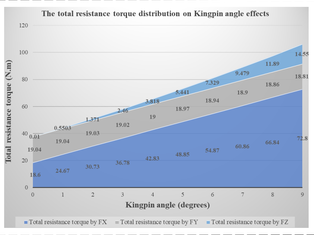


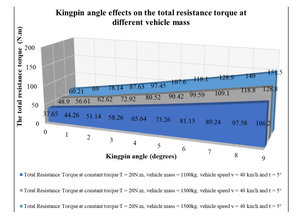




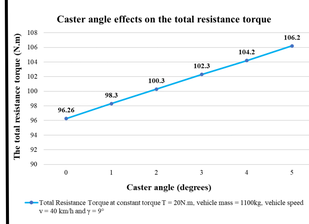
Changing in vehicle speed

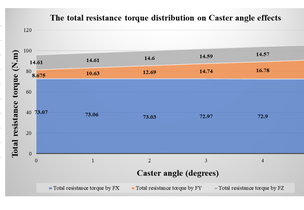


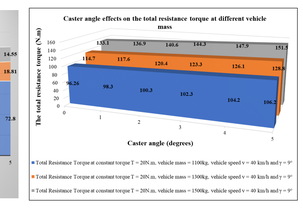




Changing in Kingpin vehicle wheel alignment







Changing in Caster vehicle wheel alignment

8 Conclusion and future plan:

- The main conclusion obtained in this Capstone project is how the wheel alignment especially Caster angle and Kingpin angle affect to the resistance moment in collaboration with specific factors such as vehicle mass, vehicle velocity,... Through all the figures mentioned above, we can conclude that wheel alignment has the huge impact on the total steering resistance torque in collaboration with vehicle mass and vehicle speed.
- In the future, it is recommended to develop this steering mechanism model and going further to simulate different situations by assist simulator such as Matlab/Simulink base on all relevant theories that mentioned in this Capstone project to provide the exact results in comparision with reality.

9 Acknowledgement:

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