VEHICLE ACTIVE STEERING SYSTEM

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This report is submitted in partial fulfillment of the requirement for the award of Bachelor of Electronic Engineering (Industrial Electronics) With Honours

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Special dedicated to my beloved parents, family, lecturers, friends, who had strongly encouraged and supported me in my entire journey of learning.

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ABSTRACT

For a better safety and stability in a vehicle, active steering system is developed. Vehicle handling and ride characteristics combined with the mechanics of road-tire interaction are greatly influenced the vehicle stability. Thus, active steering control is needed to help the driver react in a sudden occurred of unexpected disturbance. This project will discuss about an active steering system that capable of rejecting the external disturbances that will affect the vehicle stability

ABSTRAK

Active steering" dibangunkan untuk membolehkan sesebuah kenderaan mempunyai system keselamatan dan kestabilan yang lebih baik.. Pengawalan dan ciri-ciri pengendalian sesebuah kenderaan beserta mekanik yang terlibat diantara tayar kenderaan dan jalan raya adalah faktor penting yang mempengaruhi kestabilan sesebuah kenderaan. Oleh itu, "*active steering*" diperlukan untuk membantu pemandu bertindak balas kepada gangguan luar yang datang secara tiba-tiba. Projek ini akan membincangkan tentang sistem pemanduan aktif yang dapat menolak gangguan dari luar yang dapat memberi kesan kepada kestabilan kenderaan.

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BAB 1

INTRODUCTION

1.1 Introduction of project

Active steering is developed to achieve a better safety and stability for a vehicle. Active systems such as active suspension, antilock braking system, traction control an active system have been develop to improve a vehicle stability and safety. The vehicles are become unstable because of the disturbance injection torque caused by braking forces and side wind. However, the performance of the vehicle stability system has been greatly increased due to increasing of the vehicle capabilities. This project will discus about an active steering system that capable of rejecting the external disturbances that affect the vehicle.

1.2 Objective

The objective of this project is to develop a control in active steering system using the state-feedback controller that is capable of satisfying all the designing requirements .A single track car model is used in the study .Different road friction coefficient and various disturbance will be observed as the varying parameter to see the robustness and effectiveness of the proposed control. Performance of each case and its ability to attenuate disturbance in term of yaw rate as well as side slip angle will be simulate together.

1.3 Problem statement

Vehicle handling and ride characteristic combined with the mechanics of road-tire interaction are greatly influenced the vehicle stability. To ensure the vehicle stability, all four tires must always contact with the road surface. Furthermore, the associated friction between the medium also plays role in vehicle handling and ultimately ride. All four tires of a car should have a uniform grip on the road. In adverse conditions, when there water or loose gravel on the road, one or more tire may lose grip. Demands for better ride comfort and controllability of road vehicles are pursued by many automotive industries by seriously considering the use of active steering.

1.4 Scope of work

1. The scope of this project is to develop an control of active steering system based on a quarter car model using the state feed-back system
2. To study the concept of passive steering system
3. To study the concept of active steering system
4. To drive the mathematical model of an active steering system state-feedback controller for the active steering
5. To simulate side slip angle, yaw rate in Matlab/Simulink

1.5 Methodology

1. Literature Review

   - Active steering electronically varies the degree to which the front wheels turn in relation to steering input from the driver. Under normal driving conditions at low and medium speeds, the steering ratio becomes more direct; reducing the amount the steering wheel must be turned. This enhances the car's performance in city traffic, when parking or in curves. At high speeds, the steering ratio becomes more indirect, thus providing superior directional stability and very good, stable steering response.
   - Based on my researches, active steering system has been used before but with other controller such as explicit controller, fuzzy controller, state feedback controller, sliding controller

2. Mathematical model

   - To derive the mathematical model for active steering system based on state feedback controller

3. Software Design
   - Preparing the all the mathematical model and control design, based on steering system and state feedback controller
   - Run the simulation and acquire the expected result

BAB 2

BACKGROUND STUDIES

2.1 Steering System

Steering system, in automobiles, is one of the components used to control the direction of a vehicle's motion. Because of friction between the front tires and the road, especially in parking, effort is required to turn the steering wheel. To lessen the effort required, the wheel is connected through a system of gears to components that position the front tires. The gears give the driver a mechanical advantage. For example, the multiply force have been applies, the distance the wheel turning(steering wheels input) will also increase in order to turn the tires at the given amount The function of the steering system is to steer the front wheels in response to driver command inputs in order to provide overall directional control of the vehicle

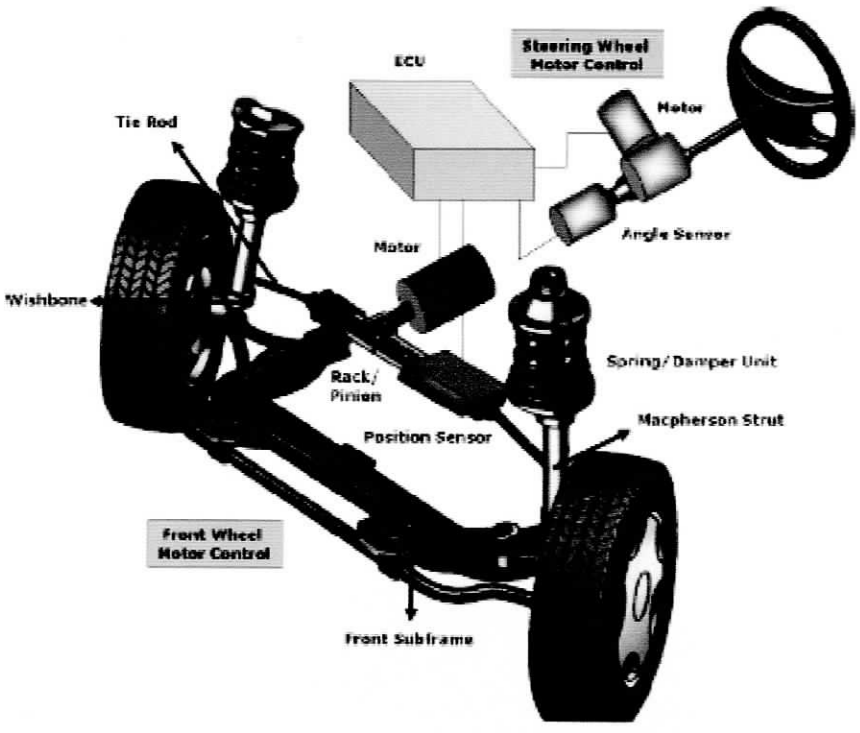

Fig 2.1: Example of steering system (stay by wire system)

2.2: Principle of Steering System

2.2.1: Under steering

Understeer is a term for a car handling condition during cornering in which the circular path of the vehicle's motion is of a markedly greater diameter than the circle indicated by the direction its wheels are pointed. The effect is opposite to that of the oversteer and in simpler words understeer is the condition in which the front tires don't follow the trajectory the driver is trying to impose while taking the corner, instead following a more straight line trajectory

This is also often referred to as pushing, plowing, or refusing to turn in. The car is referred to as being 'tight' because it is stable and far from wanting to spin. As with oversteer, understeer has a variety of sources such as mechanical traction, aerodynamics and suspension. Classically, understeer happens when the front tires have a loss of traction during a cornering situation, thus causing the front-end of the vehicle to have less mechanical grip and become unable to follow the trajectory in the corner.

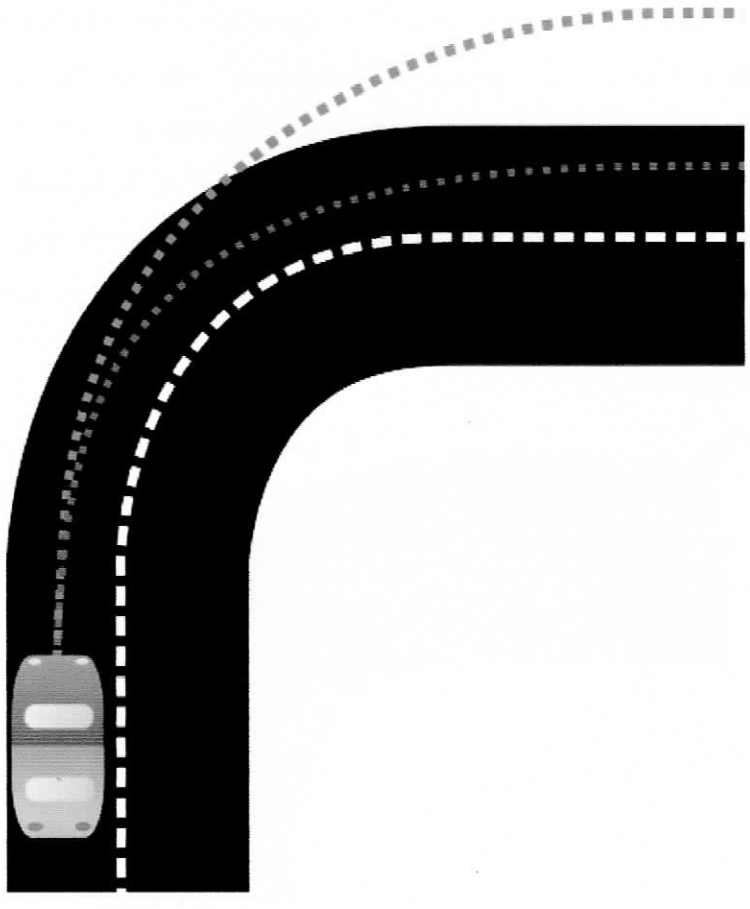

Fig 2.2: Understeering

2.2.2 Oversteering

Oversteering is a phenomenon that can occur in an automobile which is attempting to turn. The car is said to oversteer when the rear wheels do not track behind the front wheels but instead slide out toward the outside of the turn. Oversteer can throw the car into a spin. The tendency of a car to oversteer is affected by several factors such as mechanical traction, aerodynamics and suspension, and driver control. The driving technique called opposite lock is meant to cope in this circumstance. Limit oversteer happens when the rear tires exceed the limits of their lateral traction during a cornering situation before the front tires do, thus causing the rear of the vehicle to head towards the outside of the corner. More generally oversteer is the condition when the slip angle of the rear tires exceeds that of the front tires. Rear cars are generally more prone to oversteer, in particular when applying power in a tight corner. This occurs because the rear tires must handle both the lateral cornering force and engine torque.

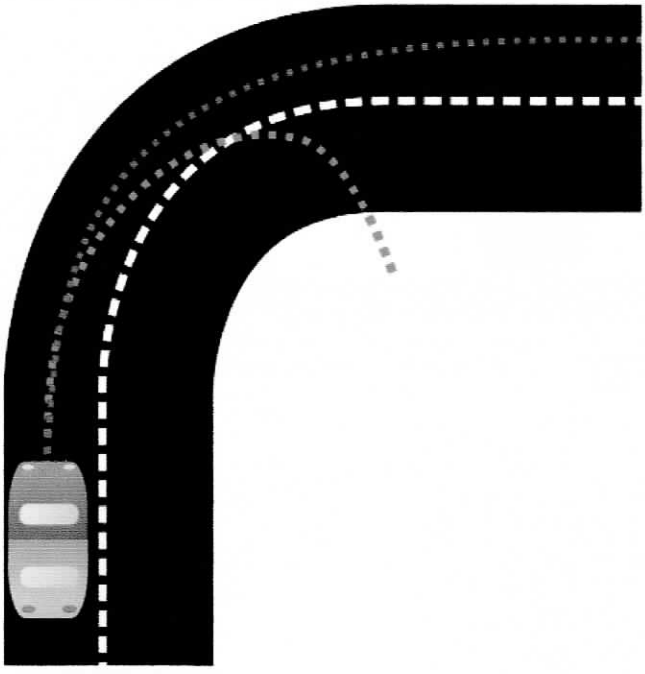

Fig 2.3: Oversteering

2.3: How the Steering Work

Starting at the most familiar place, the steering wheel, attaches a long splined shaft that goes down into the steering column and exits through the floor above the accelerator and brake pedals. This shafts only job is to rotate in place along with the steering wheel. The rotating shaft goes into the steering box housing, which is bolted directly to the frame of the car itself. The shaft ends at a small gear inside the box that contacts and meshes with another gear at a 90 degree angle. Being driven by the first gear, the second gear exits the steering box as a shaft that twists in unison with the first shaft.

The end of that arm attaches to a long bar that sits perpendicular to the front/back line of the car and ends near the front wheels of the vehicle. At each end of the bar is attached a 'Tie Rod' in figure2.4. These tie rods then attach to the actual wheel spindles them and push or pull the wheels in either direction with the center bar. The tie rod ends are pivotable at each end in order to allow vertical movement of the suspension, or bouncing that a vehicle endures during road travel.

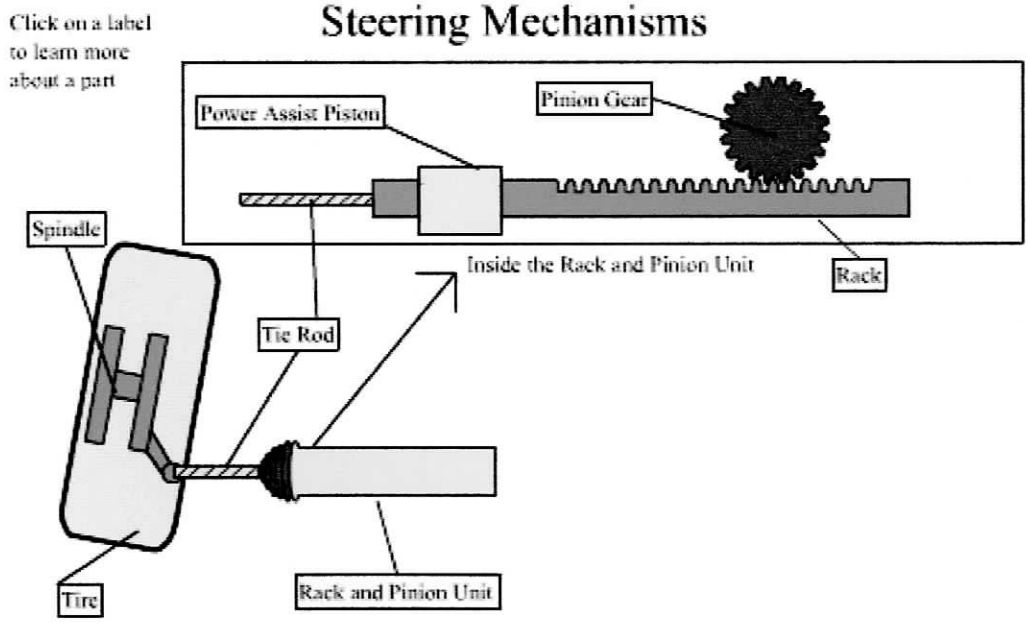

Fig 2.4: Steering Mechanisms

2.4: Type of Steering System

There are two common type of steering system, passive and active system

2.4.1 Passive Steering

Based on the Fig 2.3 for a conventional steering system, road wheel angle has a direct correspondence to driver command at the steering wheel

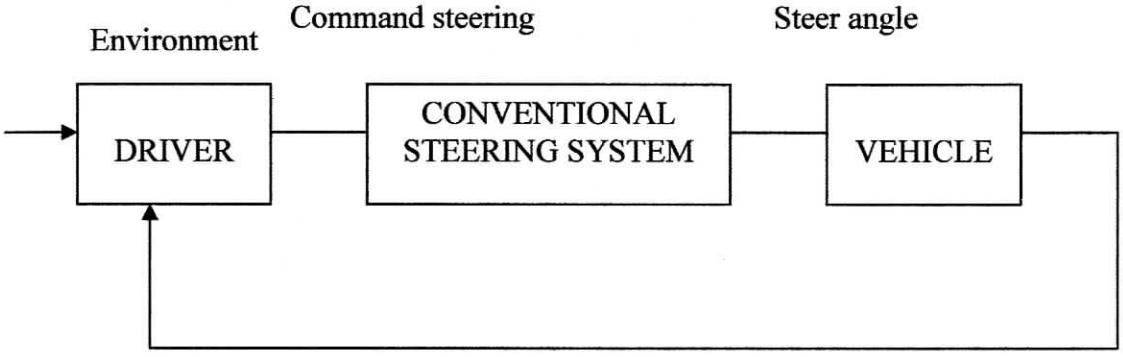

Fig 2.5: Passive steering system