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EPS Control Logic Software Component Module Definition and Evaluation

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Abstract. EPS (electric power steering) systems need the control logic parameters tuning and mechanical parameters tuning to provide a better steerability and good steering feel. Both well combined tuning techniques will provide the best steering feel to the drivers. This paper studied about the EPS control logic component module. A computer model in the loop system was used to predict the steering effort/feel while tuning the control logic parameters. This research used Matlab Simulink for control logic and 27 degree of freedom vehicle model, CarSim software. Then the steering effort results were evaluated with the vehicle experimental data.

Keywords: Control Logic, Co-simulation, Electronic Control, EPS, Steering Effort, Steering System

1 Introduction

EPS plays a role to assist the steering torque using an electric motor unlike the hydraulic power steering system using engine power. This causes weight reduction and improvement of fuel efficiency and is now a popular system to be used. However, EPS has a demerit that provides an artificial feel to the driver. Thus to provide a better steerability and steering feeling EPS control logic components and tuning [1] become important. The steering parameters and chassis kinematics are also important factors to improve better steering feeling [2]. Therefore this research tries to make a EPS control logic which consists of several different compensation components and define each specific functional module. Combining steering system and vehicle system the simulation environment was built first and results were validated comparing with experimental data.

2 EPS control logic

Each car manufacturer has different logic module. The purpose of each logic is the same in that point it needs to provide better steering feel and steerability. This research studies and makes five specific functional control module as shown in Fig. 1.

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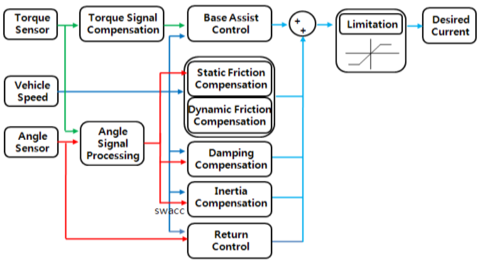

Fig. 1. C-EPS Control Logic

The above control logic component consists of friction compensation control, damping control, inertia compensation control, return control and base assist control. Each component module is to calculate the value of the compensation current receiving an input of a steering torque sensor, a speed sensor of the vehicle and a steering wheel angle sensor. Target current (desired current) value is the output calculated by adding or subtracting five values of the compensating currents from each control logic component.

3 EPS control logic component definition

3.1 Base assist control

Assist torque map is a parameter that determines the basic assist torque needed. The value of the assist current is determined in accordance with the vehicle speed and the column torque input. The magnitude of the assist torque increases as the vehicle speed decreases and the column torque increases.

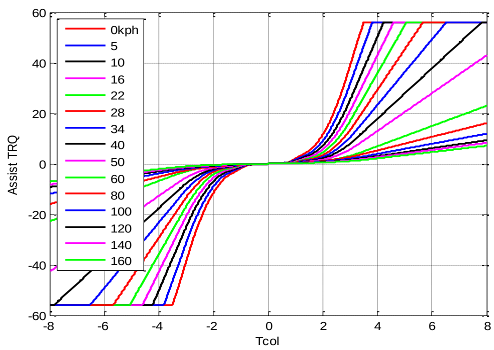

Fig. 2. Base assist torque map

3.2 Friction control

Friction control allows to adjust the compensation current proportional to the torque change rate under the input of the steering angle velocity and the vehicle speed and improved a feeling of friction on center.

3.3 Damping control

Damping control increases the steering stability by applying a compensation current to be inversely proportional to the steering angular velocity. Damping control logic receives an input of the steering angular velocity and the vehicle speed.

3.4 Inertia control

Inertia is controlled by applying a compensation current proportional to the steering angle acceleration to improve a feeling of inertia receiving the input of the steering angle acceleration and the vehicle speed.

3.5 Return control

Return control is to generate a restoring force in the opposite direction under the input of the vehicle speed and the steering angle to improve the stability. Centering torque must be set larger in the low speed than at high speed.

4 Simulation results and comparison

We confirmed that the control logic provides a result corresponding to the vehicle test data by comparing the actual vehicle test results and simulation results with the steering angle input of 28deg at the vehicle speed of 80 k/h as shown in Fig. 3.

Fig.2 is a graph of the steering torque over time.

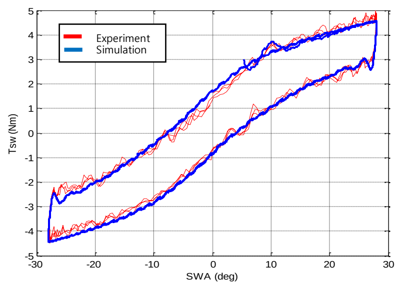

Fig. 3. CMDPS Simulation Comparison

5 Conclusion

The steering system model is based on Matlab Simulink and established the configuration of the control module of EPS.

EPS control logic module is composed of five components. The underlying logic of the five component modules are the assist controls. The final target torque is determined by the amount of assist torque map. The friction compensation control is control the magnitude of hysteresis on the on / off center. Damping control is for improving steering stability and increases the hysteresis. Inertia compensation control is to reduce the torque due to the inertia at the beginning of steering. Return control generates a restoring force at a low speed according to the steering angle to improve the steering stability.

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