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Four-Wheel Steering System

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Four-wheel steering (4WS) is an advanced control technique which can improve steering characteristics. Compared with traditional two-wheel steering (2WS), four-wheel steering systems steer the front wheels and rear wheels individually when cornering, according to vehicle motion states: speed, yaw velocity and lateral acceleration [1]. Four-wheel steering can enhance handling stability, improve the active safety for a vehicle, and allow a vehicle to turn in a significantly smaller turning radius.

When a vehicle enters a curved path, the rear wheels first steer in the opposite direction of the front wheels in order to generate sufficient yaw motion. Then, the rear wheels synchronize with the front wheel to keep the desired yaw rate value and to control the lateral motion for path tracking [2].

The lateral motion in the y-axis of an automotive vehicle is considered when analyzing steering systems. Lateral motion of the automotive vehicle implies how the vehicle responds to steering input. A human driver (HD) controls the lateral dynamics of a vehicle by indirectly affecting the forces generated by the wheels of the vehicle [3]. These forces are influenced by many systems, including the steering system of an automotive vehicle.

The response of the automotive vehicle to steering input is predominantly influenced by a steer-by-wire (SBW) all-wheel-steered (AWS) conversion mechatronic control system. Conventionally, vehicle steering systems are used to control

the lateral motion of the vehicle [4]. Research and development (RD) on this subject is broken down along the following lines; RD work on active front-wheel steering (FWS), active rear-wheel steering (RWS) and all-wheel steering (AWS) systems [5]. Specifically, this publication focuses on the SBW four-wheel-steered (4WS) conversion mechatronic controller that influences the wheels direction in different modes, as shown in Figure 1.

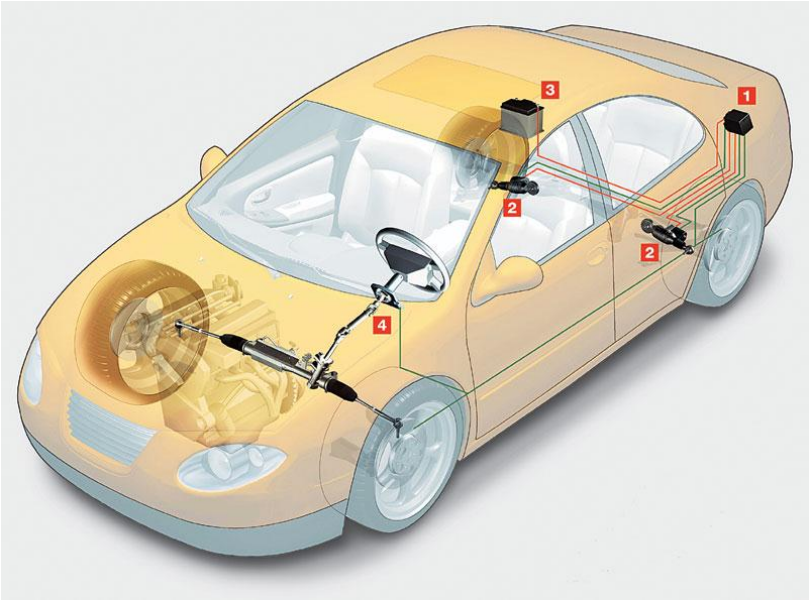

Figure 1 – Four-Wheel Steering System

Four-wheel steering (4WS) systems control both front and rear steering angles as a function of driver input and vehicle dynamics. The front-wheel steering (FWS) controller alters the direction of the front wheels as a function of the drivers input with or without a mechanical link. Active FWS provides an electronically controlled superposition at an angle

to the steering wheel angle. Active FWS optimizes features such as steering comfort, effort, and steering dynamics. However, the rear-wheel steering (RWS) controller does not influence the front-steering angle (this task is left to the driver) but rather affects the vehicle dynamics by adjusting the steering angle of the rear wheels. For vehicles operating under normal operation circumstances, controlling lateral dynamics using a SBW 4WS conversion mechatronic control system is desirable; here the front and rear steering angles are the two control inputs.

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