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A Concept for an Electrohydraulic Brake System with Adaptive Brake Pedal Feedback

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The reduction of CO2 emission in spite of increasing individual mobility requires different drive technologies as an alternative to combustion engines. One way to solve this conflict is the development of electric vehicles. For these vehicles in addition to the electric drive and battery technology the brake system is of great importance.

This paper describes a concept for an electrohydraulic brake system for electric vehicles that provides the braking assistance by a high dynamic controlled motor. The brake system consists of a tandem master brake cylinder, an electric power brake booster, a complete valve control unit with pump and wheel brakes. The brake pedal displacement applied by the driver is transmitted through the pedal gear ratio and an elastic push rod to the primary pistons of the master brake cylinder. This displacement is assisted by the electric power brake booster, which consists of a current controlled motor and transmission that converts the motor torque to a force on the piston. The displacement of the pistons in the master brake cylinder generates a pressure build-up which provides the braking torques at the wheel brakes. By using the brake pedal feedback force to the driver as a controlled variable for a superimposed control of the electric power brake booster a highly dynamic pressure build-up is an automatic byproduct. Additionally, the control concept offers the possibility to generate a variable brake pedal feedback for the driver by a reference variable expressed as a function of variables of the braking system and vehicle dynamics. By this, the haptic impression of the brake pedal force as well as the perception of the vehicle deceleration can be influenced and adapted to the current driving condition. With this control concept, the brake system is particularly suitable for vehicles with recuperative braking, as combined recuperative and friction-based braking can be done with minimal influence on the adaptable brake pedal feel. This system fulfills the requirements of recuperative braking while providing a high level of comfort. Additionally, due to its structure the system can be easily augmented by modern brake assistance functionalities.

Keywords: Electrohydraulic Brake System, Electric Power Brake Booster, Haptics, Variable Brake Pedal Feedback