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Research on Straight Line Stability Control Strategy of Four Wheel Drive Vehicle Based on the Sliding Mode Variable Structure Control and Optimization Algorithm

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Abstract

After the reference of straight line stability control strategy of four-wheel drive vehicle, this paper proposes a control algorithm combining the sliding mode variable structure and optimization control method. The control algorithm is mainly divided into the upper generalized moment calculation based on the sliding mode variable structure controller and the lower torque distribution controller based on the optimization algorithm, also including the slip rates controller based on PID algorithm to ensure the straight line stability control. This paper establishes the combined model based on the CarSim and MATLAB, and tests to verify the validation of the control strategy through the four-wheel drive vehicle test-bed based on RT_LAB. The simulation and experimental results show that when the tire-road friction coefficient is low, the control strategy can not only make the vehicle tire slip rates stay near the optimal slip ratio, at the same time through the yawing moment adjustment, ensure the yaw angle of vehicle not beyond 0.5 deg/s, so the method can effectively ensure the straight line stability of four wheel drive vehicle.

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Keywords: Four-Wheel Drive Vehicle; Sliding Mode Variable Structure Control; Optimization Algorithm

1. INTRODUCTION

Four-wheel drive vehicle is one kind of the distributed vehicles, compared with traditional fuel vehicle, its power and acceleration performance better. At the same time, the in-wheel motor makes the vehicle structure more simplified, because of no complicated mechanical transmission link between the

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wheels and power source, not only the energy efficiency is greatly improved, but also the vehicle vibration and noise become less^[1-3]. Meanwhile, it is easier to implement electronic active chassis and convenient to realize dynamic control. The main control unit and actuators of four-wheel drive vehicle are shown in figure 1^[4].

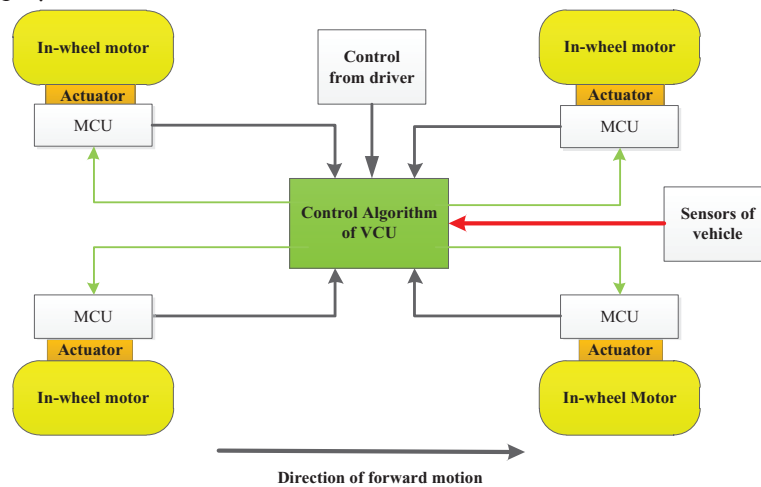


Fig.1 Main Control Unit And Actuators of Four-Wheel Drive Vehicle

The control units are mainly including the vehicle controller unit, the motor controller units and the braking controller units. The main function of the vehicle controller unit is to get the driver's operation intention according to the feedback of the vehicle state, and give the torque order to the motor controller units and braking controller units, based on vehicle stability control strategy. The motor controller and braking controller units receive orders from vehicle controller unit, and send out the control instruction to the actuators. The target vehicle actuators include four in-wheel motors and mechanical brake units^[5].

To complete the straight line stability control strategy of four-wheel drive vehicle, the hierarchical control strategy is used, with the following advantages: (1) according to the respective functions, this controller can clearly clarify the state variables and the input/output relationship;(2) hierarchical control structure makes the control algorithm more simplified, complex nonlinear relationship and uncertainty of vehicles is handled by the upper controller, and the complex constraint conditions and the nonlinear characteristics of tires will be calculated by the lower controller^[6-8].

2. THE ESTABLISHMENT OF CONTROL STRATEGY

2.1. The upper controller design of the driving stability of the straight line

According to the structure of the four-wheel drive vehicle, this paper proposes a control strategy based on the sliding mode variable structure algorithm and optimization algorithm. The control strategy is shown in Figure 2:

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