Double Motor Rear Wheel Independent Driving Vehicle Control System

Ji Peng, Zhang Tao

Hebei University of Engineering, College of Mechanical and Equipment Engineering, Handan, Hebei, China

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Abstract: in This Paper, the Control Goal of the Wheel Slip Ratio is Established in the Research of Dual-Motor Rear-Wheel Independent Drive Vehicle Control System, But Combining the Influences of Centripetal Force, Tire side Declination and Axle Load Transfer Which May Be Encountered during the Driving Process of the Vehicle, It is Proposed to Establish Electronic Differential Control Strategy and the Matlab/Simulink Platform Are Also Used to Establish the Simulation Model Analysis. the Result Shows That the Dual-Motor Rear-Wheel Independent Drive Vehicle Control System Can Effectively Control the Slip Rate during the Vehicle's Straight-Line Driving and Turning, as Well Realizing the Vehicle Effective Drive Control.

1. Introduction

Centralized drive and distributed drive are the powertrain of electric vehicles. In the centralized drive mode, the motor that changes the internal combustion engine still has the structure of the transmission system, while in the distributed driving mode, the wheel independent driving mode is set in combination with the electric vehicle's own structural form, comparing with the centralized drive electric vehicles and internal combustion engine vehicles, because the distributed electric vehicles have significant advantages in terms of maneuverability, controllability, feedback braking, and internal space utilization of the vehicle body. So the driving process needs to be realized by means of the design of the differential system, as the differential research system includes two aspects of special motor design and electronic differential system regulation motor research [1].

2. Double Motor Rear Wheel Independent Drive System

In this paper, the threshold control theory is applied, and the two-axis real-time hybrid driving concept car is selected as the research object, focusing on the electronic differential system regulating motor.

The differential system research includes two aspects: adaptive differential special motor design and electronic differential system regulating motor. This article mainly studies the electronic differential control system under the independent driving of the double motor rear wheel [1]. The dual-motor rear wheel independent drive is one of the common system in the design process of the car, which belongs to the hybrid vehicle solution, including the operation mode of the rear electric drive and the front mechanical bridge as well as the rear electric bridge at the same time, in the structural form of 1.

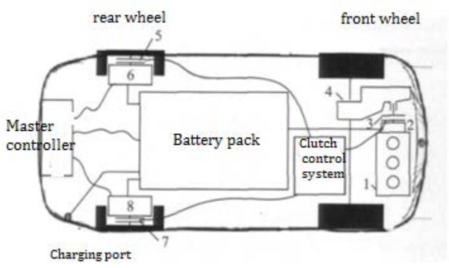

Fig.1 Structure Diagram of Dual Motor Rear Wheel Independent Drive System

In the structural design process of the dual-motor rear wheel independent driving system, the front mechanical bridge adds an ISG motor, which still has the traditional front-end power form, transforming the transmission in the traditional design into the gear of i = 0.85 transmission ratio and the operation of the overdrive in the 5-speed transmission is achieved. The two wheel clutches of the two driving motors and the controller together form the rear electric bridge, so the two driving motors are connected to the two wheel clutches to share the same drive unit.

A car driven by a rear electric axle can be seen as a dual-motor rear-wheel drive vehicle. The two electric wheels adopt the no mechanical differential connection mode, and the driving motors of the two electric wheels are adjusted and controlled by the electronic differential control system, that is, the differential process when the car turns [3].

3. The Design Electronic Differential Control System

The design and application of the electronic differential system can realize the differential-free connection between the two electric wheels of the rear electric bridge and promote the real-time hybrid driving of the two axes. The deformation of the tread surface is one of the main causes of the initial slip of the tire. As the slip rate increases, the wheel torque and driving force also increase, which can cause some tire treads to slip on the ground, showing a linear relationship between the slip rate and the driving force. On hard roads, pneumatic tires have the greatest driving force at 15% to 20% slip. With the further increase in the slip rate, car tires began to face unstable conditions and the car will be affected by many unidentified conditions during the actual driving process, which also has a variety of uncertain disturbance factors. At this time, it is difficult to determine the target slip ratio of the driving wheel by detecting the road surface conditions. Research in the process of driving a car is generally an ideal study, and it is difficult to fully reflect on the actual driving condition of the car at this time. In this paper, the electronic differential control strategy is proposed to adjust the operation mode of the driving motor, and the threshold control theory is used for the design, and the tire slip rate is studied under normal driving conditions of the car, so that it can adapt to most vehicle conditions [4].

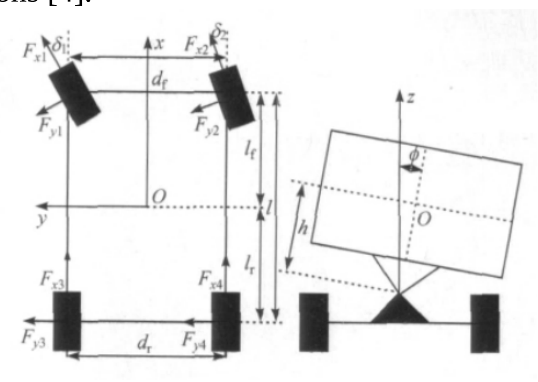

Fig.2 Schematic Diagram of the Vehicle Dynamics Model

During the process of turning the steering wheel by the driver, the electronic differential system is activated, and the angle sensor can instantly detect the change of the steering wheel rotation angle and upload the detected data to the electronic differential controller. The vehicle's control algorithm can analyze these data, combined with the inner and outer wheel speed ratios equivalent to the turning radius ratio, the Ackerman turning model, etc., using the collected steering wheel rotation angle to calculate the initial value of the inner and outer driving wheel speed.

The calculated value is compared with the vehicle speed, and the wheel slip rate calculation formula is used in the calculation of the slip rate under the initial value of the speed. This results is in a slip rate of 15% to 20%. If the calculated value is within this range, the initial value of the rotational speed is the output, and if the calculated value is outside the range, the initial value of the previous cycle is output, while the critical value becomes the initial value. But if the tire slip rate exceeds 15% to 20%, the initial value of the rotation speed in this calculation period will also exceede this interval. Therefore, the initial value of the previous calculation cycle can be 15%~ Tire slip rate between 20% [5].

The Ackerman steering model is shown in Figure 1 below.

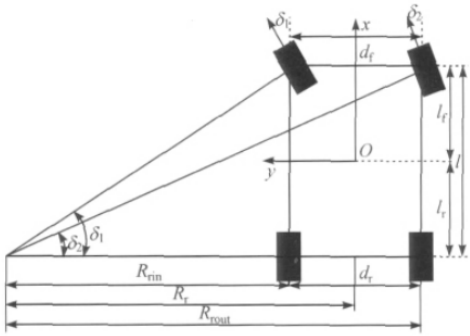

Fig.3 Ackerman Steering Model

In the design process of the whole vehicle dynamics model, it is necessary to study the degrees of freedom along the x, y axis longitudinal and lateral movements of the x-axis roll rotation, and the z-axis yaw.

Through the study of geometric relations in composition, it can be concluded that:

$R_{rin} = R_r - d_r/2$

$R_{rout} = R_r + d_r/2$

In this equation, the steering radius of the wheel in the rear electric bridge is represented by R rin , the turning radius of the rear electric axle is represented by R rou , the left front wheel angle is represented by δ1 , the right front wheel angle is represented by δ2 , and the rear wheel is represented by dr which indicates that the wheelbase is represented by l.

Iω0 represents the steering angle transmission ratio, assuming 16 can be:

$i\omega 0 = d\delta/d\beta$

$\cot\delta 2 - \cot\delta 1 = k/l$

In this equation, the knuckle angle is expressed by β, the steering wheel angle is represented by δ, the distance between the two kingpin centerline extensions and the ground intersection is represented by k, and the knuckle angle is δ2 during the left turn of the vehicle.

4. Data Analysis of Simulation Results

4.1 Building a Simulation Model

The Matlab/Simulink platform is used in the construction process of the electronic differential system simulation model, including the slip rate control module and the initial speed value module to simulate the running condition of the vehicle.

The motor model and simulated vehicle related parameters are shown in Table 1.

Table 1 Motor Simulation Model and Vehicle Main Parameters

Code/unit	Data	Code/unit	Data
ms/kg	1 256	pr	0.35
m/kg	1 395	Ixx/(kg·m2)	328
lf/m	1. 33	KT	1. 397 5
l/m	2. 55	Czf	0. 18
lr/m	1. 22	pf	0. 35
dr/m	1. 53	Uc/V	240
Cd	0. 5	Rs/Ω	0. 1

The vehicle starts in the left turn direction and the speed is 11km/h. As the sine wave function increases, the steering wheel rotation angle also increases, and the period is half of y = 120 sin (πx/10), with a maximum value of 120 °, which is the 5th s. After that, the steering wheel is returned to positive, and it is completed at the 10th s. At this time, the steering wheel rotation angle is zero, and the steering wheel rotation angle is expressed in y, and the steering wheel rotation time is expressed in x, in seconds.

4.2 Analysis of Simulation Results

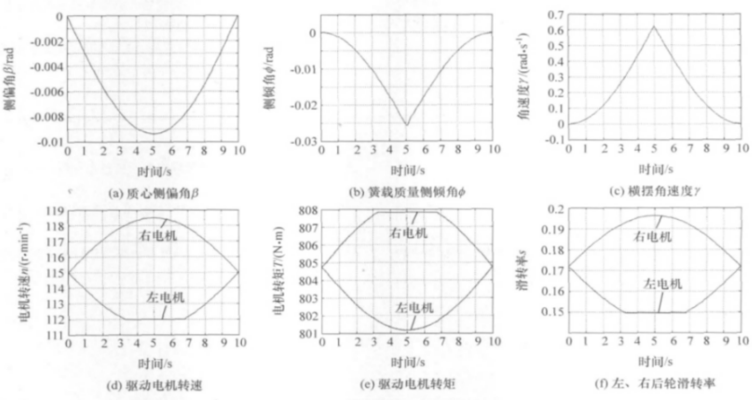

Fig.4 Vehicle Simulation Results of the Electronic Differential System

At a vehicle speed of 11km/h, the steering wheel is at the maximum angle of 120°, which is the 10th time point. At this time, if the car has an electronic differential system, the speed of the left rear wheel motor is significantly reduced, and the torque is increased, and the torque of the right rear wheel motor is lowered, and the speed is increased. In the range of 15% to 20% of the left rear wheel slip rate higher than the predetermined value, the electronic differential system can keep the left rear wheel motor speed at about 112r/min, and the slip rate is already within the set range. So the driving torque can be in the vicinity of the maximum value, and the car without the electronic differential system is in the range of 15% to 20% beyond the predetermined position.

5. Conclusion

The control system of the rear-wheel drive motor independent driving vehicle is studied. The purpose is to achieve a good wheel slip rate, since the steering of the vehicle is affected by the centripetal force and axle load transfer, the threshold differential control theory can be used to establish the electronic differential speed, in order for the control system to adjust the torque and motor speed in combination with the actual running condition of the car, as the simulation model is built for this study. The result shows that the design of the electronic differential control system can control the wheel slip rate within the safe driving range of the vehicle during the running of the vehicle, which can ensure the stability of the vehicle.

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