

# Analysis on Key Technologies of Distributed Drive Electric Vehicle

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## Abstract

In recent years, the global energy shortage and environmental pollution have become a worldwide problem. The traditional automobile belongs to an industry with high energy consumption and high pollution. The global automobile industry has begun to actively explore a new development path and develop in the direction of electrification and intelligence. In this context, electric vehicle came into being. Distributed drive electric vehicle is a kind of electric vehicle, and its key technology research and development has always been the focus of many automotive and industrial experts.

## Keywords

Distributed Drive; Electric Vehicle; Key Technology.

## 1. Introduction

According to the survey and research, by 2022, the car ownership in our country has reached 395 million, including 302 million cars, and 481 million motor vehicle drivers, showing a rising trend. It can be seen that the development of our country's automobile industry is not very fast, and cars have brought some convenience to people's travel, but also brought some problems, such as high energy consumption, serious environmental pollution, etc. Take environmental pollution as an example, the most typical one is automobile exhaust pollution, which has a very serious impact on urban air quality. For example, the contribution rate of automobile exhaust in Beijing's PM<sub>2.5</sub> has reached 22.2%, which is one of the main factors causing urban smog.

## 2. Overview of Distributed Drive Electric Vehicles

All electric vehicles are driven by power supply and motor, involving machinery, industry, electronic equipment and other disciplines. According to different standards, electric vehicles can be divided into different types. According to the energy source of electric vehicles, electric vehicles can be divided into BEV, PHEV, FCEV, etc; According to the structural layout of the drive system of electric vehicles, it can be mainly divided into centralized electric vehicles and distributed electric vehicles. The so-called centralized electric vehicles use motors to replace traditional internal combustion engines, mainly single axle drive. Compared with the traditional drive system, the entire drive system has less changes, and the layout of motors is more flexible. Distributed drive electric vehicles are gradually emerging.

The distributed drive electric vehicle has four motors, which are placed at four corners of the vehicle. A reducer is installed at two corners behind the vehicle, and four motor controllers are installed respectively. The battery pack mainly includes fuel cell+DC/DC+hydrogen tank.

### 2.1. Advantages of Distributed Drive Electric Vehicles

Compared with the traditional centralized drive electric vehicle, the most obvious feature of the distributed electric vehicle is that each wheel of the vehicle can be driven independently, which can effectively reduce the frequency of drive failure. The advantages of distributed electric vehicles are mainly reflected in the following aspects:

### **2.1.1. Improve the Accuracy of Vehicle Active Safety Control**

The active safety control of traditional vehicles is carried out by driving or braking the wheels. Generally speaking, the dynamic characteristics of the vehicle are improved by changing the force conditions of the vehicle. The distributed drive electric vehicles all use the motor as the power source. The motor can not only brake the vehicle, but also recover the kinetic energy, which is conducive to improving the braking effect of the distributed drive electric vehicles. In addition, the motor has the characteristics of high accuracy and fast response time. Therefore, the driver can understand the force situation of the whole vehicle through the feedback of the motor, and intervene in the vehicle, so as to better adjust the running state of the vehicle.

### **2.1.2. It is Conducive to Improving the Flexibility of Vehicle Chassis Layout in the Distributed Drive Electric Vehicle Structure System, There is No Engine, Transmission Shaft, Etc., But Motors and Motor Controllers**

Therefore, technicians can flexibly arrange electrical components according to specific needs. In addition, distributed drive electric vehicles are driven by motors, which is conducive to enhancing the integration of vehicle power transmission and makes it possible to flexibly set electrical components. There are also technicians who adjust the position of electrical components in the car body to improve the stress condition and dynamic characteristics of the distributed drive electric vehicle.

### **2.1.3. Realize the Purpose of Integrated Vehicle Control**

One of the most important developments of distributed drive electric vehicles is the integration and coordination of electronic control systems, such as ESC, AFS, ACC, etc. For traditional cars, different electronic control systems have different control modes, which to some extent increases the difficulty of vehicle coordinated control and brings bad experience to drivers. For the distributed drive electric vehicle, the main power source is the motor. The driver can effectively solve the problem of uncoordinated electric vehicle operation system by controlling a single motor, which makes the operating system of the distributed drive electric vehicle more convenient, which is conducive to improving the reliability of the operation of the distributed drive electric vehicle.

### **2.1.4. Precise Control of Each Wheel of the Car**

Each wheel of the distributed drive electric vehicle can be controlled separately. Therefore, technicians should comprehensively consider the road conditions, battery motor status and other information, so as to calculate the best driving/braking torque, which can better improve the dynamic characteristics of the vehicle, so that the driver can accurately control each wheel. Even facing different road conditions, it can also ensure the smooth operation of the vehicle.

### **2.1.5. Improve the Stability of Vehicle Operation**

Distributed drive electric vehicles include several motors, which improves the stability of the vehicle system to some extent. If a motor fails, the vehicle system will automatically reconstruct its working mode, and distribute the internal driving force of electric power among the remaining driving motors. This not only can ensure the stability and safety of the distributed drive electric vehicles, but also give full play to the value of the remaining driving force, so that the vehicle system can still operate.

### 3. Analysis of Key Technologies of Distributed Drive Electric Vehicle

#### 3.1. Suspension Integration

#### 3.2. The Main Feature of the Distributed Drive Electric Vehicle is That Each Wheel can Brake and Steer Independently

In order to facilitate the adjustment of the vehicle track, wheelbase, etc., the suspension and wheels can be made into a suspension assembly, and the suspension assembly can be installed on the vehicle frame according to the vehicle design drawings, so that the position of the vehicle wheels can be better adjusted. The components of the suspension assembly mainly include shock absorbers, guide mechanisms, wheel speed sensors, etc. This suspension adopts the form of double longitudinal arms, leaving a large space in the middle, so that the vehicle can install active suspension shock absorbers. In addition, the suspension assembly support is mainly connected to the inside and outside through hinges, so that the sensor can measure the force of both the inside and outside parts. In addition, a vertical force sensor is installed on the shock absorber, which can facilitate the acquisition of transverse force and longitudinal force through mechanical analysis. Compared with the tire six component force sensor, this measurement method has lost some accuracy, but the installation cost is relatively low, which can effectively reduce the construction cost of the vehicle. In addition, a special steering mechanism is installed on the suspension integration. The lead screw nut mechanism can be used to turn the motor to translation and then to rotate. This steering mechanism is conducive to improving the independence of the suspension. Each vehicle suspension is also independent of each other, and can achieve four-wheel steering, in-situ steering, etc.

#### 3.3. Frame Structure

The frame structures of distributed drive electric vehicles are different. This paper focuses on the "longitudinal beam+suspension assembly". The main structures are the electronic master cylinder system, strong current controller, etc. The longitudinal beam, parts and suspension of the vehicle are connected together by bolts, which is convenient to adjust the position of vehicle parts, especially the power supply position. The specific parameters of the distributed drive electric vehicle are shown in Table 1:

**Table 1.** Specific parameters of distributed drive electric vehicle

Parameter	Numerical	Unit
Vehicle mass	155	kg
Sprung mass	83	kg
Unsprung mass	72	kg
wheelbase	$2 \times 10^3$	mm
Track width	$1.1 \times 10^3$	mm
Centroid distance to front axle	$1 \times 10^3$	mm
Centroid height	400	mm
Wheel radius	203	mm

#### 3.4. Electrical System

The main power source of the distributed drive electric vehicle is the motor. The battery is mainly responsible for storing energy. The quality of the motor directly determines the power performance of the vehicle. The battery determines the endurance integration of the electric vehicle. Therefore, it is no exaggeration to say that the motor and battery are the core of the entire electric vehicle.

First of all, whether the motor of the electric vehicle can adapt to the driving conditions of the vehicle, such as car starting, car acceleration, car deceleration, etc. The basic performance comparison of the current common electric vehicle driven electric motor is shown in Table 2:

**Table 2.** Comparison of basic performance of electric motor driven by electric vehicle

parameter	Brushed DC Motor	Induction Motor	Permanent Magnet Brushless DC Motor	Switched Reluctance Motor
power density	Low	medium	high	high
Peak efficiency/%	85-89	90-95	95-97	<90
Load efficiency/%	80-87	90-92	85-97	78-86
Speed range/(r/min)	4000-8000	12000-15000	4000-10000	>15000
reliability	Generally	good	excellent	good
Structural robustness	Poor	good	average	excellent
Overall dimensions	Large	medium	small	small
quality	Heavy	medium	light	light
Cost/(USD/kW)	10	8-10	10-15	8-10
Control operation performance	Heavy	medium	light	ight
Controller cost	Low	high	high	average

Secondly, the battery is the energy storage device of the electric vehicle, which directly determines the endurance mileage of the vehicle. We mainly evaluate the battery from two perspectives: energy and power. The former means that under the premise of the same quality, the battery with higher energy can release more energy to maintain the operation of the electric vehicle in the process of operation, so the endurance mileage of the vehicle will be longer. The latter means that under the same time, the battery with higher power can release more energy, which can effectively meet the requirements of high-power operation of the vehicle.

The distributed drive electric vehicle uses four sets of suspension for braking. Each brake is equipped with a special controller, and two motors share a battery. This design can not only improve the power battery of the vehicle, so that the battery can store more electric energy, which is conducive to improving the range of the electric vehicle. The strong current control integration module in the electric vehicle can also be formed into a strong current controller, which uses two poles to control two circuits to supply power to the electric vehicle motor, which is conducive to improving the safety of each system of the electric vehicle. In addition, special resistors and diodes are installed on each relay to protect the relay of electric vehicles.

### 3.5. Vehicle Controller

The whole vehicle controller is the core control component of the electric vehicle, mainly including receiving sensing signals, running the upper control algorithm, controlling the drive motor controller, etc. The electric vehicle controller is composed of a master controller and a slave controller, which communicate through CAN. The core component of the whole vehicle controller is a microcontroller, whose main function is to collect signals, output signals, etc., such as the Infineon XC2265N chip, This chip contains 16 microprocessors, 32KB RAM, 3-way CAN, 16 way AD, etc. Both the master controller and the slave controller are very complex control systems, and each module is independent of each other. In order to facilitate control, the motor controller is installed. A special circuit board is installed on the electric vehicle to avoid confusion between the main controller and the slave controller.

### 3.6. Hydraulic Pressure Line Control System

The main function of the hydraulic line control system is to provide hydraulic braking force. In this paper, the electric control main steel system+hydraulic orifice adjusting system are used. The power source of the electric control master cylinder system is a DC brush motor. The use of the lead screw nut mechanism enables the master cylinder to generate pressure. When the pressure increases, the motor can run in the forward direction. Then, the pressure sensor is used to measure the pressure, and the motor is used for feedback control. In addition, the components of the hydraulic control system by wire mainly include high-speed on-off valve, brake pipeline, etc. The main function is to control the flow direction of the brake fluid, and then use sensors to measure the hydraulic pressure of the vehicle, according to the measurement results to adjust the running state of the vehicle, so that the vehicle can be stable.

## 4. Future Development of Distributed Drive Electric Vehicles

First of all, the main power source of the distributed drive electric vehicle is the motor, which increases the vehicle weight to some extent and has a negative impact on the smooth and safe operation of the vehicle. In order to improve the reliability of the distributed drive electric vehicle, technicians can use the suspension system to suppress the wheel hub to reduce the on-board negative effect, which is conducive to improving the stability and comfort of the distributed drive electric vehicle. Therefore, in the future, the wire control subsystem distributed drive chassis and adaptive suspension system should be developed. In addition, the existing distributed drive electric vehicles have limited space for setting electronic components. In addition, their operation and working environment are relatively harsh. In order to improve the operation stability of the distributed drive electric vehicles, technicians can adopt integrated design and control methods to develop a high-quality motor system. The motor system involves many professional fields and contents, such as mechanical and electrical field, thermal energy field, etc. The motor operation environment is very complex. If the speed and torque control of the motor is not good, it is easy to lead to unstable and unsafe operation of the vehicle. Therefore, in the future, appropriate reduction system and large torque motor should be developed, and the motor structure and process should be used to improve the motor torque density.

Secondly, the tire force of distributed electric vehicles presents nonlinear and strong coupling characteristics. Each parameter of the whole tire state constitutes a nonlinear high number, and there is a very complex coupling relationship between each direction. How to use the motor feedback information to improve the state of the vehicle has puzzled many experts and scholars. To solve this problem, some experts and scholars have proposed that distributed electric vehicles can achieve accurate control of power torque and shaft torque within the motor output range, and can effectively distribute the internal drive of the motor, which is conducive to improving the economy of distributed electric vehicles. In addition, the most important development direction of distributed drive electric vehicles is the full line control chassis, which integrates drive by wire and steering by wire, providing a high degree of freedom for the integrated control of the vehicle chassis. However, due to the interaction between various subsystems of the vehicle, the most important point is how to control the decoupling of the chassis subsystem. In the future, we must comprehensively consider various factors such as vehicle coupling time-varying and disturbance, In order to achieve the purpose of collaborative control of the vehicle chassis, and to improve the reliability of the vehicle operation system.

## 5. Conclusion

To sum up, this paper focuses on the advantages and key technologies of distributed drive electric vehicles. On this basis, it analyzes the future development direction of distributed drive

electric vehicles. Our country should focus on the development technology of distributed drive electric vehicles to promote the development of electric vehicle industry.

## References

- [1] Li Zhihui. Research on energy distribution and motor temperature rise characteristics of electric drive system [D]. Jilin University, 2021.
- [2] Liu Xuan, Wang Zi Hang, Zhang Tongrui, et al. Optimal control strategy for lateral stability of port heavy haul AGV [J]. Journal of South China University of Technology (Natural Science Edition). 2021, 49 (8). 113-121..
- [3] Xue Haoyuan, Lian Jinyi, Wang Jialun, et al. Improvement of Ackerman Steering Model and Simulation of Electronic Differential Control [J]. Automotive Practical Technology. 2020, (10). 118-121.