ISSN: 2424-8460(O)
2251-2608(P)

Original Research Article

Design of Electric Vehicle Power Matching Device Based on Computer Simulation Technology

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Abstract: With the continuous improvement of computer simulation technology, people's requirements for the dynamic simulation of electric vehicles are gradually increasing. Cars play an increasingly important role in people's life in the new era. It has been gradually upgraded from a simple means of transport to a quality of life. Electric steering system as a new technology, compared with hydraulic power steering can reduce fuel consumption, good highway feeling, easy to control and other advantages, is adopted by more and more automobile manufacturers. This paper aims to study the modeling, comparison and selection, design process, design and calculation method of main components, and power assist characteristic curve of electric steering system. It provides the foundation for the design and development of electric steering system.

Keywords: Computer Simulation; Electric Vehicles; Power Matching

1. Introduction

Power matching device is a device that uses the power of the engine to help the driver steer. It converts the energy of the engine into hydraulic energy, and then converts the hydraulic energy into mechanical energy and acts on the steering wheel to help the driver steer. Therefore, it should be called power assisted steering system. It was originally installed in cars primarily to reduce the steering force applied by the driver to the steering wheel [1].

2. Hydraulic power steering of electric vehicle based on computer simulation technology

Since the 1940s, related mechanical steering system has been added to the design of the hydraulic assist system of automobiles, which is based on which to help the driver reduce the physical burden of steering. In general, there are oil pumps, V-pulleys, oil pipes, oil supply units, power AIDS and control valves. It has stable operation, lighter volume, sensitivity is opposite bigger, alleviate the pressure of the uneven road surface caused by the impact, and many other advantages, embodies the rationality and reliability, through constant development and practice of related technology matures, today still has been widely spread in the related fields, has played a vital role. Previously, the basic function of the power matching device is to meet the actual demand of steering motion, which reduces the driver's force on the steering wheel, as shown in Figure 1 below:

General Motors used hydraulic power steering on passenger cars in the 1950s to assemble a mechanical steering system [2-4]. The system is based on mechanical systems with additional hydraulic systems added. Hydraulic steering system consists of hydraulic and mechanical parts. It uses hydraulic oil as the power transmission medium, and uses hydraulic pump to drive the mechanical steering gear to achieve steering. Hydraulic power matching device is generally composed of mechanical steering device, hydraulic pump, oil pipe, distribution valve, power cylinder, relief valve, pressure limiting valve, oil cylinder and so on. To ensure

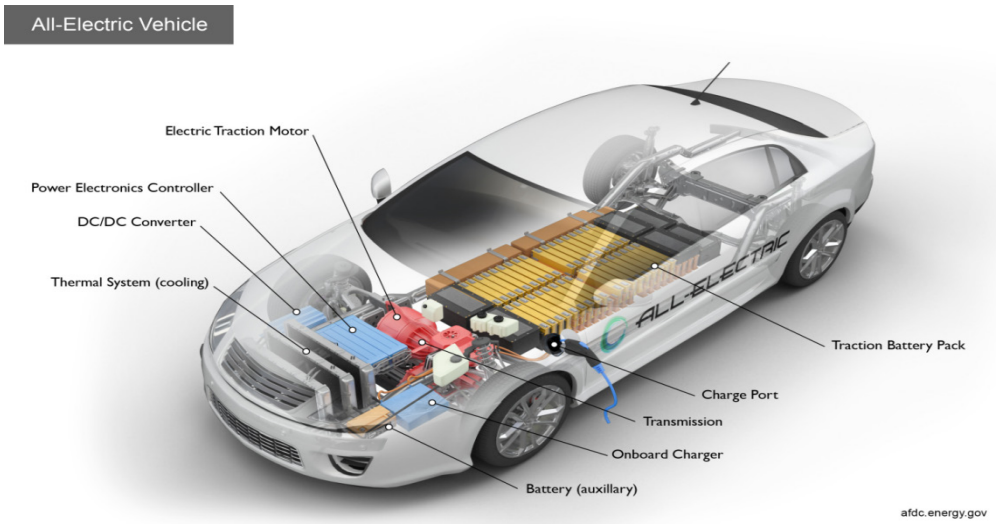

Figure 1. Power matching device design of electric vehicle obtained by computer simulation

the safety of the system, the hydraulic pump is equipped with a pressure limiting valve and a safety valve. Distribution valve, steering and power cylinder are placed in one, distribution valve and active gear shaft assembled together (spool is arranged perpendicular to the gear shaft >, spool is provided with a control device groove, and through the steering shaft on the fork toggle spool movement, calculation with the following formula:

$$F_H = fLg[q_{RO} + q_{RU} + (2q_B + q_G)] \tag{1}$$

Where Simulated friction coefficient: ff=0.02

$$q_{RO} = \frac{nq_{RO}'}{a_o} \tag{2}$$

$$\text{So: } q_{RO} = \frac{nq_{RO}'}{a_o} = \frac{3\times 10.53}{1.2} = 26.321\text{kg/m} \tag{3}$$

$$q_{Ru} = \frac{nq_{RU}'}{a_U} \tag{4}$$

a_U Distance between return branch idlers: $a_U = 3000\text{mm}$

$$\text{So: } q_{RU} = \frac{nq_{RU}'}{a_U} = \frac{1\times 26.56}{3} = 8.85\text{kg/m} \tag{5}$$

$$q_B = 23.8\text{kg/m}^2 \tag{6}$$

Q -- Material quality of conveyor belt per meter length: G kg/m

$$q_G = \frac{I_v\rho}{v} = \frac{Q}{3.6v} = \frac{1000}{3.6\times 3.15} = 88.18\text{kg/m}^2 \tag{7}$$

Substitute the above values into formula (1) :

$$\begin{aligned} F_H &= fLg[q_{RO} + q_{RU} + (2q_B + q_G)] = 0.025\times 4308\times 9.8\times[26.32 + 8.85 + (2\times 23.8 + 88.18)] \\ &= 180430.887\text{N} \end{aligned} \tag{8}$$

The steering shaft is fixed to an elastic torsion bar that acts as the center of the valve. The piston is installed at one end of the frame, located in the power cylinder, and the left end of the frame is connected with the pull rod. When the steering wheel rotates, the steering shaft (with transmission gear shaft) moves the slide valve relative to the sliding sleeve, resulting in oil passage changes. Hydraulic oil is discharged from the oil pump and flows into the power cylinder side through the control valve to push the piston to drive the rack. The steering wheel is deflected by a lever. The hydraulic power matching device is controlled by the driver and uses the pressure generated by the hydraulic pump of the car engine to achieve wheel steering. Due to hydraulic steering, the driver's manual steering torque can be reduced, improving the vehicle's steering and handling stability. To ensure the car's portability when steering or at low speeds, the displacement of the hydraulic pump depends on the flow rate of the engine when idling. After starting the car, no matter whether the vehicle turns or not, the system must be in working state. When the steering speed is slow, the hydraulic pump needs to output a larger power to obtain a larger power, so the engine power resources are wasted to a certain extent. Moreover, the steering system also has the disadvantage of low temperature performance [5-6].

3. Electro-hydraulic power steering of electric vehicle power matching device

Today, power steering has gradually been widely used in the related fields of automobile production and manufacturing. At this time, the specific performance has also put forward higher requirements, not only to achieve the reduction of operating intensity, but to ensure that the steering is light and can ensure the stable operation at high speed when turning at low speed. In recent years, under the influence of people demand, car speed increasing, under this development situation, the traditional hydraulic power steering gear gradually beginning to show weakness, unable to realize auto lights turned, low-speed driving conditions or under a state of high speed car "drift" speed design requirements: on the contrary, if you want to ensure that car at high speed stirred up moderately, when do you want to stop or turn low speed, you will feel too heavy [7]. With the continuous development of electronic technology, more and more electronic devices have been used for steering system, as shown in Figure 2 below:

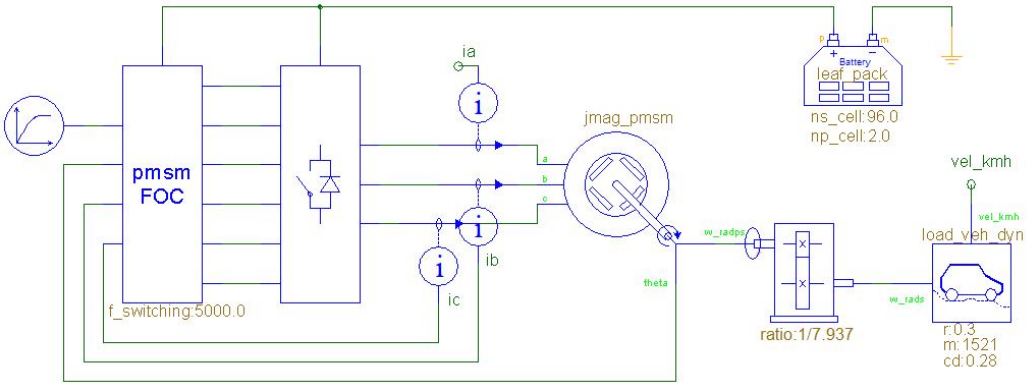

Figure 2. Current hot electro-hydraulic power matching device.

The emergence of the corresponding electro-hydraulic power matching device. Electro-hydraulic power steering can be divided into two categories: electro-hydraulic power matching device EHPS, electronic control hydraulic power steering ECHPsPl. EHPS is based on hydraulic power system development. Its characteristics are that the original hydraulic booster pump needs to provide relevant power support based on the motor,

abandoning the traditional engine driving mode, as an important measure to achieve fuel consumption saving. In 1983, Koyang corporation of Japan launched the electronic control hydraulic power steering (EHPS) system with vehicle speed sensing function. EHPS is developed on the basis of hydraulic power system. Based on the traditional hydraulic power matching device, an electronic control device is added. It features an original hydraulic booster pump driven by an electric motor rather than an engine. The method saves fuel consumption;It has a fault protection system, after the failure of electronic components can still rely on the original steering system work safely;The steering effect remains unchanged at low speed;The speed can be gradually reduced according to the speed at high speeds to increase road feel and improve vehicle performance. Stability. Electronic control hydraulic power matching device is a kind of mechatronics product, which combines hydraulic power steering and electronic control technology [8-9].

4. Application of computer simulation in electric power steering

With the continuous development and practice, more and more researchers and experts began to carry out in-depth research and exploration on this topic, and achieved certain research results.

In 1988, Suzuki of Japan first equipped the steering column assisted electric power steering system developed by Koyo on Cervo, a small car. In 1990, Honda Motor Co. , Ltd. of Japan also adopted the independently developed rack assisted electric power steering system on the racing NSX, which opened the history of electric power steering in automotive applications. EPS is developed based on EHPS. It eliminates EHPS hydraulic pumps, tubing, cylinders and seals. It relies entirely on the motor to drive the steering mechanism directly through the reduction mechanism. Its structure is simple, the number of components is greatly reduced, and the reliability is improved. It solves the chronic problems of hydraulic line leakage and inefficiency. The Honda Fit, Civic, Toyota's new Crown and Mercedes-Benz's new A-class all use electric power steering. Electric steering System An electric steering system usually consists of a torque (steering) sensor, an electronic control unit ECU, an electric motor, an electromagnetic clutch and a reduction mechanism, as shown in Figure 3 below:

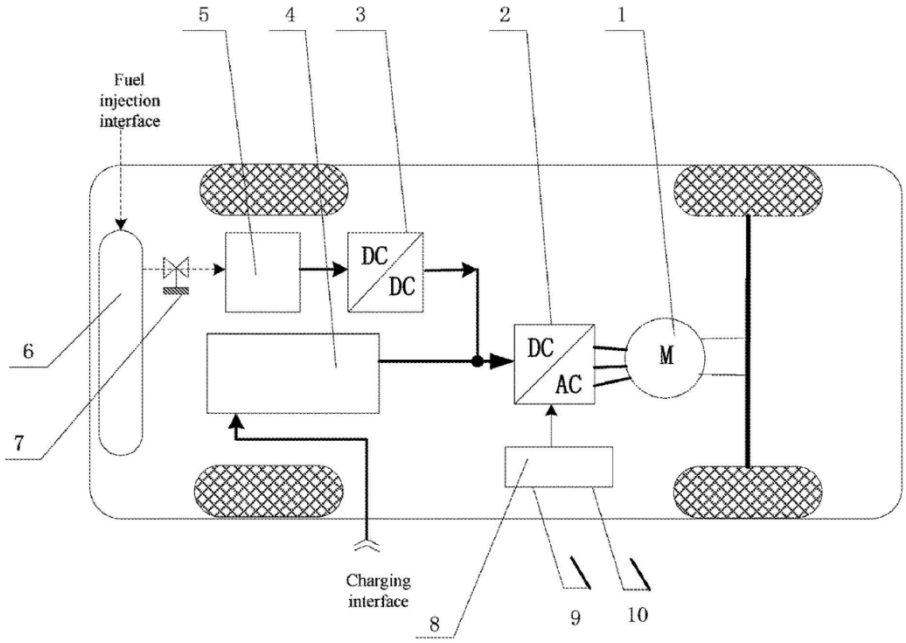

Figure 3. Power matching device of electric vehicle based on computer simulation.

Here's how it works: A torque sensor detects the driver's torque on the steering wheel and sends a signal to the control unit based on that torque. The control unit will also receive signals from steering wheel position sensors. This sensor is usually installed with a torque sensor (some sensors already integrate both functions). Torque and steering wheel position information is processed by the control unit, along with vehicle speed signals transmitted to the control unit, and pressurization instructions are generated according to a pre-designed program. The instructions are transmitted to the motor and the torque generated by the motor is transmitted to the supercharging mechanism. The gear mechanism here is used to increase the torque. In this way, the auxiliary torque is transferred to the steering column, and the power steering is finally completed. Energy consumption Savings Compared to traditional hydraulic power matching devices, no system is required to operate the pump and the motor is activated only when steering is required, thus minimizing energy consumption and fuel consumption. It also eliminates noise pollution caused by steering pumps [10].

The hydraulic power matching device needs the engine to drive the hydraulic oil pump to make the hydraulic oil flow continuously. Coupled with the pipeline flow loss and other factors, part of the energy is wasted. In contrast, EPS requires only the energy supplied by the component to the motor when steering operation is required. Moreover, the energy consumption of the EPS system is related to the steering wheel and the current vehicle speed. When the steering wheel does not turn, the motor does not work;When rotation is required, the motor starts to work under the control of the control module, and outputs the corresponding torque size and direction to generate auxiliary steering torque. The system truly implements "power on demand" and is a true "on demand" system that can save about 80% of energy in a variety of driving conditions. When the driver turns the steering wheel and then releases it, the EPS system adjusts automatically to return the wheel to the center. Software can also be used to maximize design parameters for the best return characteristics. Through flexible software programming, it is easy to obtain the torque characteristics of the motor at different speeds and under different vehicle conditions. These torque characteristics enable the system to significantly improve steering capability and provide steering return characteristics that match the dynamic performance of the vehicle. In the traditional hydraulic control system, in order to improve this characteristic, the mechanical structure of the chassis must be reformed, which is difficult to achieve.

Steering system is one of the important factors affecting vehicle stability and stability. Because the traditional hydraulic power matching device can not adjust and control the auxiliary power correctly in real time, the ability to coordinate steering force and road sense is poor, especially when the vehicle is traveling at high speed, it will still provide more power, resulting in the driver's lack of road sense. Even cars can feel the flutter, which can affect handling stability. However, EPS is powered by the motor, and the size of the auxiliary power is adjusted and controlled by the electronic control unit (ECU) according to the speed, steering wheel input torque and other real-time, and this contradiction can be well solved. The EPS control unit ECU has the function of fault self-diagnosis. When the ECU detects abnormal operation of a component (such as sensors, electromagnetic clutch, motor, power supply system and vehicle ignition system), it immediately controls the electromagnetic clutch separation and assist. Manual steering, according to the ordinary steering control work, to ensure driving safety.

5. Conclusion

Today, with the help of computer simulation technology, electric power steering has been effectively

developed and used in more and more cars and light vehicles. The device is superior to the ordinary power steering device. It automatically adjusts the steering wheel by turning the computer ECU at different speeds. If the vehicle is running at low speed, the driver can realize steering operation based on small operating force. Steering; Assuming that the vehicle is running at high speed, the steering system will increase the operating force through automatic control to achieve operational stability. It needs to be clear that, compared with hydraulic power steering gear, electric steering gear has many advantages such as high efficiency, good road feeling, and environmental protection requirements. This is an important development direction of steering gear in the future.

Acknowledgments

Science and technology program of education department of Hubei province in 2019 (Research on parameter matching optimization of power system of pure electric vehicle based on Cruise-Simulink co-simulation,B2019247)

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