Original Research Article

Research on motor control technology of new energy vehicle based on Matlab

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Abstract: With the continuous development of the world economy, the speed of resource consumption is also accelerating, the global oil resources have tended to be exhausted, and the environmental problems caused by it are also increasingly intensified. Therefore, the use of fuel vehicles has been gradually restricted, the use of new energy vehicles is more and more popular. As one of the three control components of new energy vehicles, the motor has very high requirements on stability and safety. Based on the application of MATLAB, this paper explores the improvement of motor control technology of new energy vehicles for reference.

Keywords: Matlab; New energy vehicles; Motor control; Technology

1. Introduction

Compared with traditional fuel vehicles, new energy vehicles have the advantages of good environmental protection effect, low noise, more recyclable energy and can solve the problem of alternative energy of traditional vehicles. Motor control technology is one of the key technologies of new energy vehicles, and its research is of great significance[1].

2. Analysis of working principle of motor controller

As the core part of the whole control system, the motor controller is mainly composed of inverter and control board. The on-board power battery feeds the power supply to the inverter, which converts the DIRECT current into the ac power required by the motor by the PWM wave from the control part. The motor controller receives the motor information and VCU instructions in the current state through the sensor to make decisions and judgments. The motor controller interacts with other control units of the car body through CAN bus. When acceleration and deceleration occur in the process of driving, the car sends CAN signal to the motor controller through the vehicle controller, so as to achieve the purpose of acceleration and deceleration of the car. Since electric vehicles have high requirements for the drive system, the motor drive system for vehicles needs to be characterized by high integration density, high power density, long service life and stable output. In the case of ignoring external interference, the motor mathematical model of new energy vehicles can be expressed as Formula (1) :

$$D(\mathrm{q})\ddot{q} + \mathrm{C}(\mathrm{q}, \dot{q})\dot{q} = \tau \tag{1}$$

Where, D(q) is the positive definite inertia matrix of order N *n, and C(q,) is the centrifugal force and Coriolis force.$\dot{q}$

The PD control law is

$$\tau = K_d\dot{e} + K_p\mathrm{e} \tag{2}$$

Take the tracking error as e=-q, constant value when constant control is adopted, then ==0.$q_d q_d \dot{q}_d \ddot{q}_d$

At this point, the motor equation of the car is:

$$D(\mathrm{q})(\ddot{q}_d - \ddot{q}) + \mathrm{C}(\mathrm{q}, \dot{q})(\dot{q}_d - \dot{q})K_d\dot{e} + K_p e = 0 \tag{3}$$

It can also be written as:

$$D(\mathrm{q})\ddot{e} + \mathrm{C}(\mathrm{q}, \dot{q})\dot{e} + K_p \mathrm{e} = - K_d\dot{e} \tag{4}$$

Take the Lyapunov function as:

$$\mathrm{V} = \frac{1}{2}\dot{e}^T D(\mathrm{q})\dot{e} + \frac{1}{2}\mathrm{e}^T K_p e$$

The overall structure of automotive motor controller consists of shell and cooling system, power electronic power supply, control circuit, underlying software and control algorithm. The two components of motor controller are hardware circuit and software algorithm. The hardware of motor controller mainly consists of central controller module, power converter module, driver and corresponding sensor. The control software can be divided into state control, vector algorithm, demand torque and diagnosis module. Vector algorithm is divided into maximum torque current ratio control and weak magnetic control[2-3].

The central control module is composed of hardware circuit and control software. The hardware circuit mainly includes the microprocessor and its smallest system, such as PWM generation circuit, reset circuit, sensor signal processing circuit and interactive circuit.

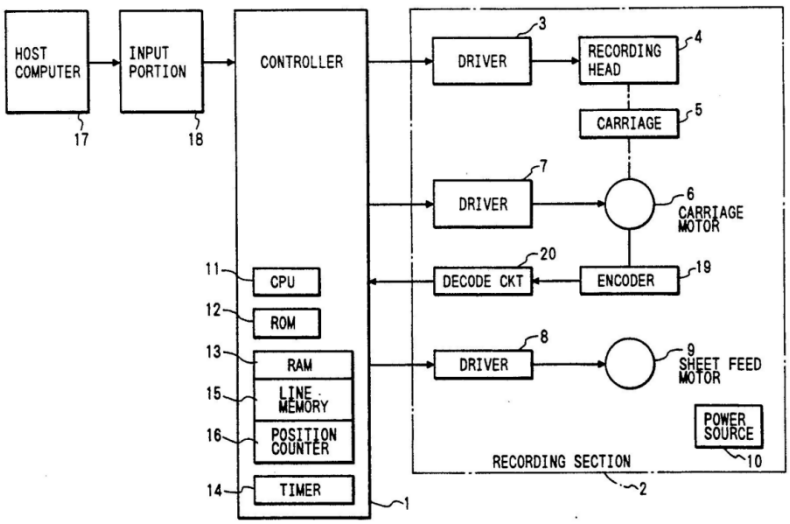

Figure 1. Specific automotive motor control technology.

The drive control module converts the instructions of the central controller into the on-off instructions of the inverter. The drive control module also has the function of detecting and protecting the over-current voltage, and realizes the isolation function of power signal and control signal[4-6].

Sensor modules mainly include current, voltage, temperature, motor shaft sensors, etc. The detected signal will be transmitted to the central processor for calculation, and alarm signal will be sent through CAN interface after the protection range is exceeded. The use of traditional motor controller in the automobile has brought many disadvantages. For the whole vehicle, the volume of the battery is fixed in the process of driving, so as far as possible to improve the efficiency of the motor and electronic control, so that the automobile can achieve high power density, high torque and high efficiency of driving. The new motor controller becomes one of the research hotspots of new energy vehicle enterprises. Permanent magnetization, digitalization and integration are the development direction of new energy vehicle electric drive.

3. Basic operations of Matlab/Simlink

MATLAB was originally launched by MathWorks of the United States to solve the development of linear al-

gebra science computing software. The name comes from a combination of the first three letters of Matrix and Laboratory, known as Matrix Laboratory.

MATLAB after the continuous in-depth development and improvement of researchers, into a multi-functional software. It is widely used, especially in engineering, such as matrix manipulation, image processing, development algorithms, data visualization, financial modeling, numerical calculation, data analysis, mathematical symbol calculation and so on. MATLAB can not only draw two-dimensional graphics, but also draw three-dimensional graphics. It provides convenience for many fields of research.

Simulink is an important part of MATLAB. It is an integrated environment for modeling and simulation of dynamic systems in the MATLAB environment. Simulink is a visual simulation tool. Simulation module model can be established in Simulink, set different parameters, run the simulation program, and combined with MATLAB programming language simulation, from which the simulation results can be obtained.

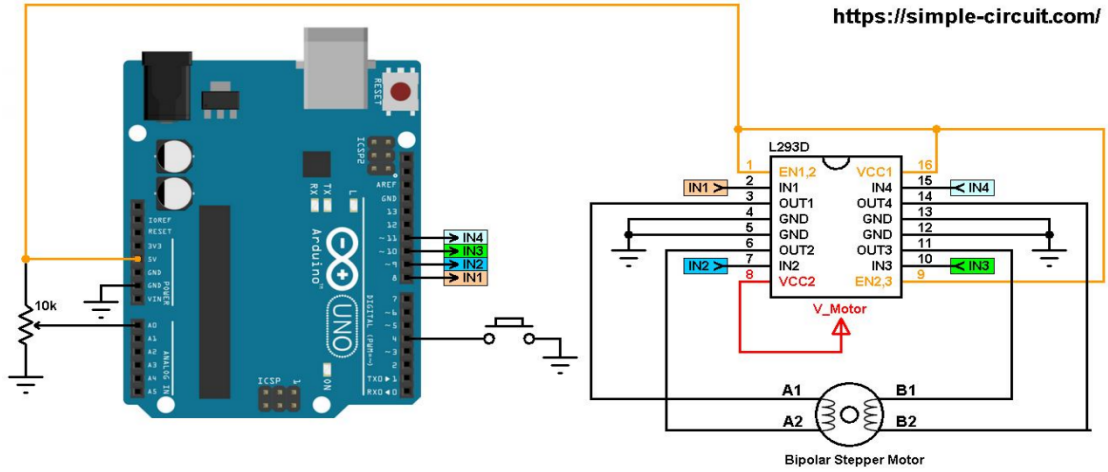

Figure 2. Automotive motor control based on Matlab.

In the MATLAB/Simulink environment, it is not necessary to input a large number of programs, just select the appropriate library module for simple operation, you can construct a complex simulation system. It supports continuous sampling, discrete sampling and two kinds of mixed sampling. It has the advantages of simple operation, wide application, precise simulation, high calculation efficiency, clear flow, clear structure and easy to transplant the model code to DPS/FPGA and other hardware[7].

Simulink modeling and simulation, the first need to Simulink -. Some basic operations to learn. It includes the operation of the module in Simulink, the operation of the signal line between the modules and the simulation operation of the last module, etc.

3.1. Module operations

Module operations include operations on a single module or multiple modules. Click a module to select a single module. To perform operations on multiple modules, press Shift.

To Delete a module, select the module and press Delete, or use Ctrl+X to cut the module.

By default, the input end is on the left and the output end is on the right. If you change the direction of a module, select the module, right-click the Format menu, and Rotate the Module by 180° or Rotate Block by 90°. Alternatively, use Ctrl+R as a combination, but note that the input is in English. At the same time, you can also add a logo to the module. Double-click the module to have a text area, then the editing bar will appear. After input, you can exit editing by single left button in any other position in the model window. Multi-module operation also has a point for the module parameter setting, double-click the module can open the parameter setting dialog box[8-9].

3.2. Operations on signal cables

Similar to module operation, you can drag and hold down the left mouse button to move a signal cable, and use Delete to Delete a signal cable. In the actual model, a signal needs to be sent to multiple inputs of different modules, so the branch line of the receipt signal is needed. The operation procedure is as follows: Point the mouse pointer to the starting point of the branch and press the right mouse button. After the mouse pointer turns to a cross, drag the mouse to the terminal of the branch and release the right mouse button. If a module has only one input port and one output port, select the module to be inserted, hold down the left mouse button, and drag it to the signal cable. In addition to this operation, sign can also be added to the signal line. Double-click the signal line to be added with the left mouse button, and fill in the required sign in the pop-up blank text. After input, you can exit the editing by single left button in any other position in the model window.

3.3. Simulation operation

After the Simulink model is built, it can be simulated and run. Click the "Simulation start or Continue" icon in the toolbar of the model window to start the simulation; After the simulation starts, the icon of "Simulation start or Continue" becomes the icon of "simulation pause", as shown in **Figure 3** below:

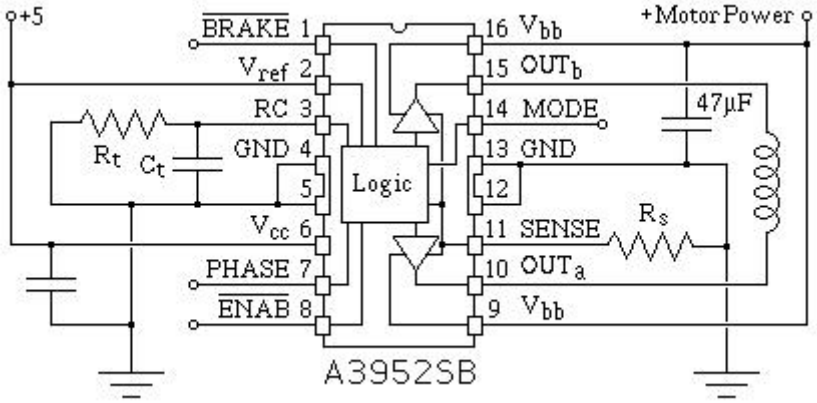

Figure 3. Automobile motor control module in simulation operation.

After the simulation, the icon changes back to the "Simulation start or Continue" icon. During the simulation, you can use the "Stop simulation" icon to terminate the simulation. The simulation results are output or displayed in the homing module[10].

4. Conclusion

With the enhancement of people's awareness of environmental protection, the concept of sustainable development is more and more popular. New energy vehicles have the characteristics of low noise, no pollution and low use cost. At the same time, the government has introduced policies to vigorously support the new energy vehicle industry, so it can be seen that new energy vehicles have a good market prospect in the future. Motor control system as the core technology of new energy vehicles, its control effect directly affects the performance of electric vehicles. The analysis of the structure and working principle of ac motor controller is helpful to improve the balance and efficiency of motor operation.

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