Frontiers in Economics and Management Volume 3 Issue 8, 2022
ISSN: 2692-7608 DOI: 10.6981/FEM.202208_3(8).0024

Research on the Development Model of New Energy Automobile Industry under Computer Internet of Things Technology

Song Wu, Lingling Tan

China Automotive Technology and Research Center Co., Ltd., Tianjin 300300, China

Abstract

Based on the computer Internet of Things technology, this paper analyzes the engine model of new energy vehicles, the relationship between engine efficiency and speed, and the control scheme of the engine in hybrid power, and establishes the main operating state and control method of the engine in this paper. At the same time, this paper analyzes the mathematical model of FSPM motor voltage and torque and uses MATLAB/Simulink to establish a new energy vehicle drive system. The drive system includes a magnetic flux switching permanent magnet (FSPM) motor and a motor drive module, an internal combustion engine generator module, a battery module, and a control module. The starting characteristics, running characteristics at different speeds and engine shutdown running characteristics of new energy vehicles are analyzed through simulation. Through a large amount of data and images, it can be seen that the hybrid simulation model designed based on the computer Internet of Things technology can complete most of the basic principles to keep the engine running at the most efficient.

Keywords

Internet of Things; New Energy Vehicle; Engine Model; Drive Model.

1. Introduction

In recent years, the number of automobiles in China has exceeded 200 million. Economic development has brought great convenience to people's life and travel, but also caused problems such as shortage of international oil energy supply and increasingly serious environmental pollution. In order to reduce the impact of fuel vehicles on petroleum Since 2001, China has successively promulgated a series of "Decision on Accelerating the Cultivation and Development of Strategic Emerging Industries" and "Plan for Energy Saving and New Energy Vehicle Industry (2011-2020)" The friendly policy to promote the development of new energy vehicles in China has raised the development of new energy vehicles to the height of national strategic development. Since the implementation of the national policy, China has accelerated the development of new energy vehicles, and many auto companies have set foot in the field of new energy vehicles [1]. With the joint efforts of all parties, Chinese new energy vehicle technology innovation has been greatly improved, and the industrial scale has gradually expanded. At present, in the management and detection of new energy vehicles, the full application of the Internet of Things technology can better collect vehicle operation data, and provide more scientific data for the production and manufacture of new energy vehicles based on archive data, road data, etc. Support, the organic combination of the Internet of Things analysis technology and the development of the new energy vehicle industry can promote the further development of the new energy vehicle industry. Based on the Internet of Things technology, this paper analyzes the structure of the dual-rotor motor hybrid power system and various operating conditions on the basis of the stator permanent magnet type flux-switching dual-rotor (hereinafter referred to as DR-FSPM) motor, and uses MATLAB simulation software to establish a hybrid powertrain. The system simulation model and the optimal control strategy

ISSN: 2692-7608 DOI: 10.6981/FEM.202208_3(8).0024

of the internal combustion engine are used to simulate the typical operation mode of the vehicle, so as to analyze the feasibility of applying the DR-FSPM motor to the new energy vehicle.

2. The Working Principle of the New Energy Vehicle Drive System

2.1. The Working Principle of Internal Combustion Engine

Internal combustion engine, commonly known as engine, refers to a device that uses liquid fuel to burn to generate output torque, and its output torque comes from the combustion of gasoline or diesel in the cylinder. The combusted gases push the cylinder drive shaft, which in turn pushes the output shaft to rotate [2]. The combustion completeness of gasoline and the size of the accelerator all affect the output torque, so the output power of the internal combustion engine is related to the valve and the engine speed. In general, the valve opening size and engine speed are positively correlated with the output power below the rated speed, but the randomness of combustion makes it difficult to give its analytical expression in general. There has been a lot of literature on this issue. Generally speaking, for the most common Stirling engine, the fuel consumption of each operating point of the engine can be obtained by numerical calculation in Figure 1.

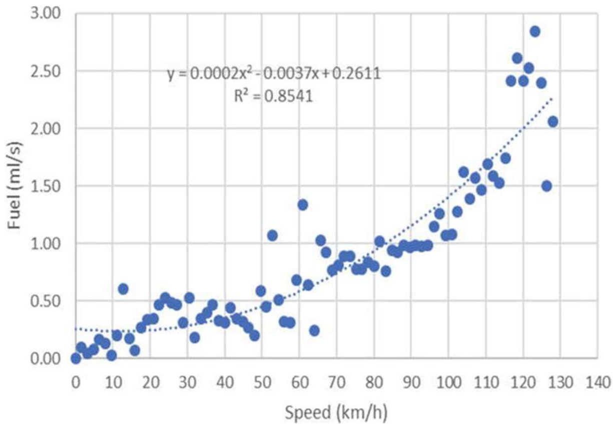

Figure 1. Fuel consumption and output power at various speeds

The output efficiency of the engine varies with the speed and the valve, the abscissa is the engine speed, and the ordinate is the engine output power, the unit is kW. Each point in the image represents a certain output power and a certain fuel consumption. By connecting the same fuel consumption points, an ellipse-like image can be drawn as shown in the figure [3]. The size marked on the ellipse is the fuel consumption size on this curve. The intersection of the horizontal line and the curve in the figure is when the engine is 2200rpm, the output power is 40kW, and the fuel consumption at this time is 275g/kwh.

2.2. The Working Principle of the Hybrid Drive System

Hybrid can be divided into plug-in and non-plug-in in terms of energy sources. This paper mainly discusses the non-plug-in type, and its main design idea is to keep the engine running at the optimal operating point as much as possible. That is, the optimal operating point in Figure 1, the fuel consumption is 255g/kwh, but different road conditions and acceleration and deceleration requirements make the input energy of the car motor a random data. In order to maintain the optimal operation of the engine, the battery is required to reserve excess energy. When the engine energy is insufficient, the battery can also be added to drive together [4]. There are many structures in the way of hybrid power transmission. For example, the battery can also directly drive the electric motor. The engine can also charge only the battery while

ISSN: 2692-7608 DOI: 10.6981/FEM.202208_3(8).0024

stationary. The drive motor can also regeneratively charge the battery when the vehicle is parked. A comprehensive analysis of various results is shown in Figure 2.

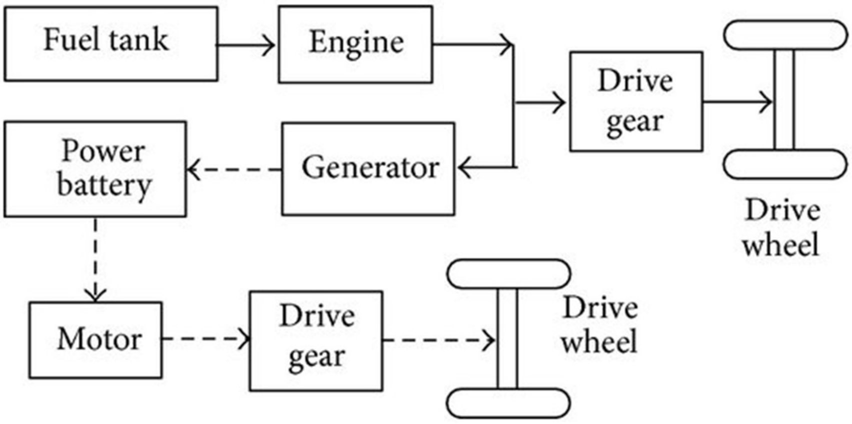

Figure 2. Energy flow diagram

The simulation mode used in this paper is the series simulation mode, in this case, the engine is kept running at the optimal operating point most of the time. The main target of the design is not long-term highway vehicles, but some urban vehicles. Because the traditional car has only one energy source, the internal combustion engine, the energy source must be designed to ensure the high-speed operation of the vehicle, so the engine capacity is generally large [5]. For the hybrid power in this paper, the two energy sources can also reduce the engine capacity a lot. In most cases, the large-capacity engine of traditional vehicles cannot play its due role at all. The hybrid makes up for this design bottleneck, and maximizes the efficiency of the engine through the design of dual power sources (Figure 3).

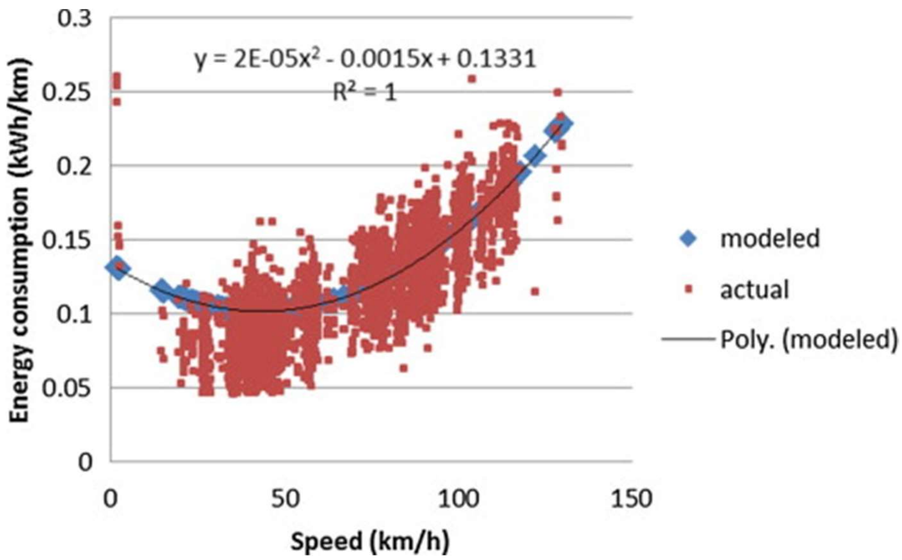

Figure 3. Power consumption comparison at speed

2.3. Design of New Energy Vehicle Drive System

Figure 4 shows the basic design analysis. The upper left side is the engine part, and the lower side is the battery and DC transformer part. The upper right part is the control part, and the lower right part is the motor and drive part.

ISSN: 2692-7608 DOI: 10.6981/FEM.202208_3(8).0024

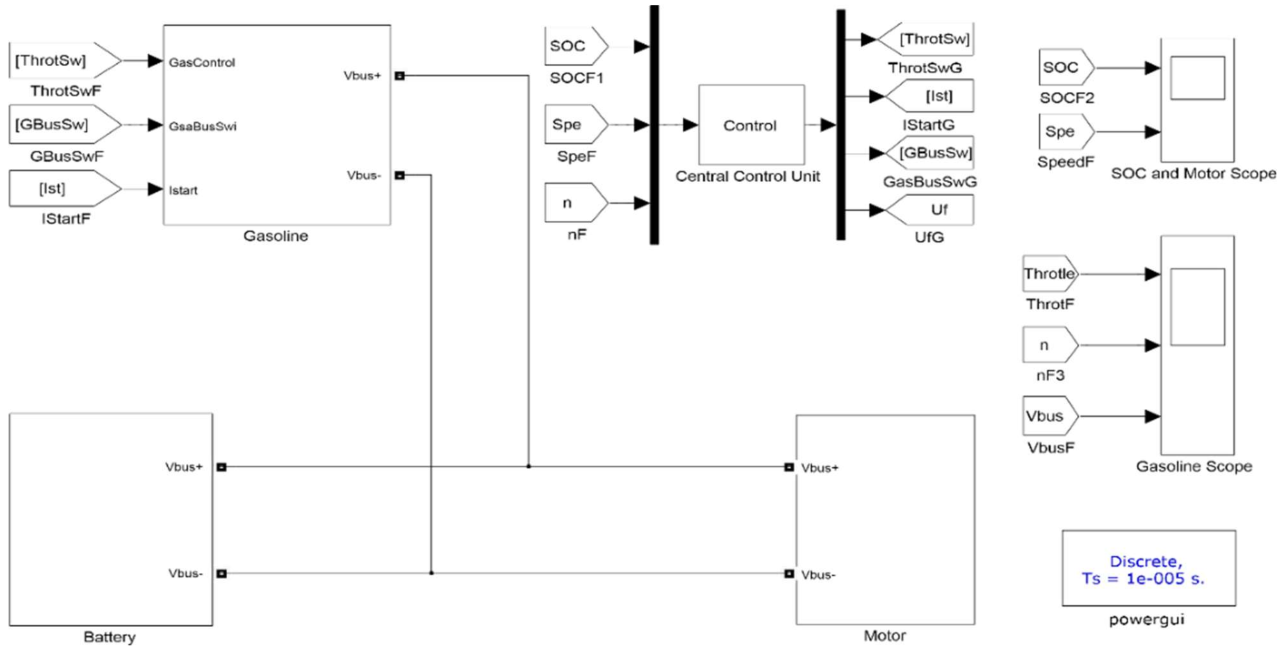

Figure 4. Overall Design

For the rated engine speed, when the excitation voltage is constant, the no-load electromotive force and internal resistance of the circuit are constant. Because the engine output power can only ensure its high operating efficiency when it is at a certain value. Then since the no-load electromotive force is determined, according to Joule's theorem, as long as the output current is guaranteed to be stable, the output power can be guaranteed to be stable. As long as the voltage of the output section is kept stable, the current I1 flowing into the main line and the load current I2.

$$I_1 = (E - U)/R \tag{1}$$

Current I3 flowing into the battery:

$$I_3 = I_1 - I_2 \tag{2}$$

engine power P:

$$P = EI_1 \tag{3}$$

In this way, the power of the engine can be guaranteed to be stable, because the engine is designed to maintain the rated speed, so the engine valve can maintain a constant value.

3. Design of Motor and Motor Drive Part

If the difference between the actual current and the calculated reference current exceeds the loop width, the switch state will be changed according to whether it exceeds or is less than. Because the motor is an inductive load. So, the stator current will inevitably produce the opposite change. Because the three-phase reference current is a sine wave, the result of the hysteresis should also be a sine wave.

ISSN: 2692-7608 DOI: 10.6981/FEM.202208_3(8).0024

The inverter circuit uses a general three-phase bridge circuit. The upper and lower arms of each bridge arm represent the positive and negative changes in voltage. Each bridge arm has two switches, and the switches use ideal switches [6]. The input of the motor is the bus voltage, and the source of the voltage signal is the DC voltage rectified by the battery or generator module. The stator voltage equation is transformed into:

$$\begin{bmatrix} u_d \\ u_q \\ u_0 \end{bmatrix} = \frac{d}{dt}\begin{bmatrix} \psi_d \\ \psi_q \\ \psi_0 \end{bmatrix} - \begin{bmatrix} \omega\psi_q \\ -\omega\psi_d - \omega_e\psi_m \\ \psi_0 \end{bmatrix} + \begin{bmatrix} r & 0 & 0 \\ 0 & r & 0 \\ 0 & 0 & r \end{bmatrix}\begin{bmatrix} i_d \\ i_q \\ i_0 \end{bmatrix} \tag{4}$$

The AC-DC-axis voltage equation can be obtained as follows:

$$u_d = \frac{d}{dt}\psi_d - \omega_e L_q i_q + r i_d \tag{5}$$

$$u_q = \frac{d}{dt}\psi_q + \omega_e L_d i_d + \omega_e \psi_m + r i_q \tag{6}$$

Arranged the AC-DC-axis voltage equations 7 and 8.

$$u_d = -\omega_e L_q i_q r i_d \tag{7}$$

$$u_q = \omega_e L_d i_d + \omega_e \psi_m + r i_q \tag{8}$$

The total power injected by the motor:

$$P_s = \frac{3}{2}\left[(u_d - R i_d) i_d + \left(u_q - R i_q\right) i_q\right] \tag{9}$$

$$P_s = \frac{3}{2}\left[-\omega_e L_q i_q i_d + (\omega_e L_d i_d + \omega_e \psi_m) i_q\right] \tag{10}$$

$$P_s = \frac{3}{2}\left[\omega_e \psi_m i_q + \omega_e\left(L_d - L_q\right) i_d i_q\right] \tag{11}$$

The available electromagnetic torque is as follows:

$$T_{em} = \frac{P_s}{\omega} = \frac{3}{2}\frac{\omega_e \psi_m i_q + \omega_e\left(L_d - L_q\right) i_d i_q}{\omega} = \frac{3}{2} P_r [\psi_m i_q + \left(L_d - L_q\right) i_d i_q] \tag{12}$$

$$T_{em} = \frac{3}{2} P_r [\psi_m i_q + \left(L_d - L_q\right) i_d i_q] \tag{13}$$

Figure 5 is the comprehensive control diagram of the motor. The input signal and feedback signal control the quadrature axis current through a PI regulator, and then obtain the three-phase target stator current through the coordinate transformation of a dq axis to abc axis, and then control the switch through the inverter circuit., output the three-phase voltage and then control the right motor [7]. The output parameter of the motor is the rotor angular velocity. So,

ISSN: 2692-7608 DOI: 10.6981/FEM.202208_3(8).0024

through a gain module, the corresponding car speed is calculated. The output travel speed is obtained through a torque generating function to obtain the load torque at the current speed.

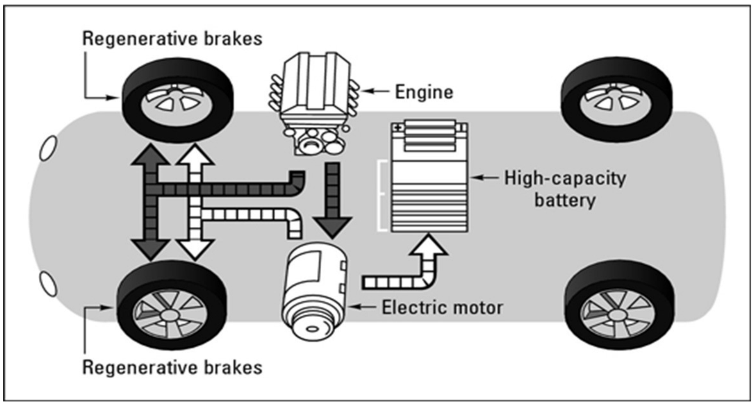

Figure 5. Overview of the motor section

4. System Test

4.1. Analysis of Starting Performance

Series hybrids use a battery-driven electric motor for direct start. For batteries and electric motors, the starting power is only limited by the output power of the battery and the capacity of the inverter. For the internal combustion engine, the engine power is related to the speed, and the starting power is very small, so the starting performance of the hybrid is very good [8]. The following is the starting situation of the motor, and the target starting speed is set to 100km/h. The starting and control of the three-phase permanent magnet synchronous motor has been described above and will not be described in detail. For the problem of large starting current, the parameters of the PI regulator can be adjusted to improve, and the reduction of the P parameter can restrain the large starting current. Figure 6 shows the three-phase starting current when the stationary battery is started.

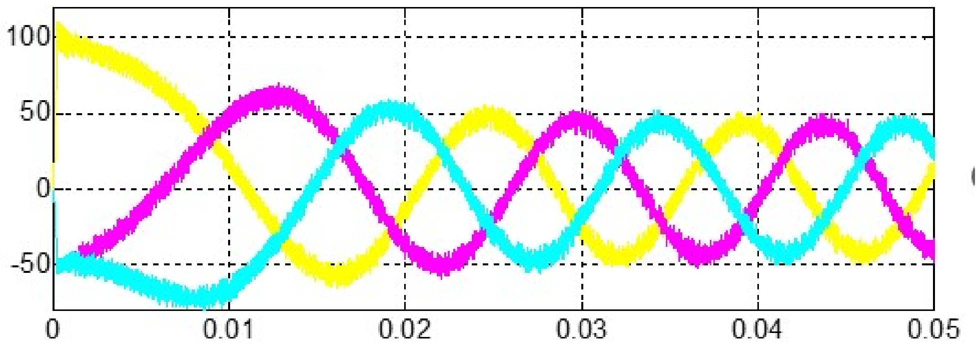

Figure 6. Stator Three-Phase Currents

4.2. Analysis of Engine Starting Performance

Figure 7 is an engine speed image. Since it takes a certain time to start the engine, in order to increase the starting performance, the starting load is added very little. After the engine has started close to rated speed, turn on the switch. Because of the addition of the load, for the main circuit, there will be a large load added. At this time, it is equivalent to adding a large resistance torque to the engine. According to the law of rigid body mechanics, the speed will have a drop at this time. As shown in Figure 7, the speed drops to a large extent at 3.1s, and the speed will recover with the increase of the valve.

ISSN: 2692-7608 DOI: 10.6981/FEM.202208_3(8).0024

$$\frac{d\omega}{dt} = \frac{T_e - T}{J} \tag{14}$$

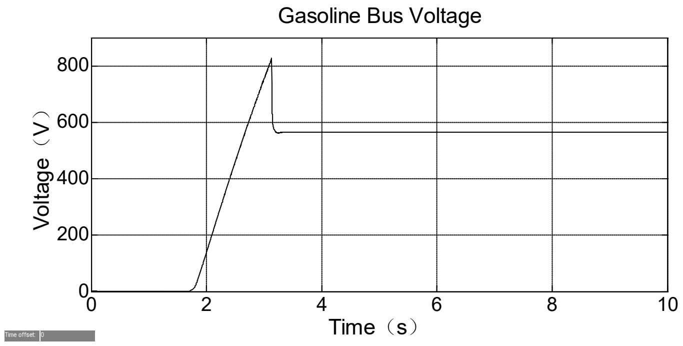

Figure 7. Engine Bus Voltage Variation

The engine starts at 1.9s. As the engine speed increases, the amplitude of the three-phase voltage output by the engine also increases. When the engine speed has reached 1450rpm, the engine is close to the rated speed at this time, and the DC voltage rectified by the three-phase alternating current is also greater than the required no-load electromotive force E. This is the master control system that controls the engine valve opening. At this moment, the bus voltage of the engine should be equal to the no-load electromotive force divided by the load, and the value of the divided voltage is determined by the internal resistance of the main line.

5. Conclusion

To apply IoT analysis technology to the development process of the new energy vehicle industry, it is necessary to conduct in-depth analysis of the relevant policies of the Chinese government and master the application points of the IoT analysis technology, so as to be able to promote the development of the automobile industry with the specific needs of the development of the new energy vehicle industry. The new energy vehicles studied in this paper represent the latest automotive research direction. Of course, when the battery capacity can be effectively improved, pure electric vehicles will also be an important direction in the industry. The pure battery driving process in this paper is consistent with the internal operation process of pure electric vehicles, and can also provide some references for the research of pure electric vehicles.

References

[1] Ju Qingjiang, Ju Peng, Dai Wenqiang, et al. Research on the impact of new energy vehicle subsidy policy and ownership: unit subsidy sales incentives and product differentiation. Journal of Management Science, vol. 24, pp. 16-22,June 2021.

[2] Zhang Kaihuang, Qian Qinglan, Chen Qingyi. The innovation spatial pattern and network characteristics of China's new energy vehicle industry from a multi-scale perspective. Advances in Geography, vol. 40, pp. 150-154,November 2021.

[3] Li Sining, Chen Kai. Pricing Strategy of Embedded Technology Services for New Energy Vehicles in a Competitive Environment. Journal of Systems Management, vol. 29, pp. 122-125, March 2020.

[4] Ren Jie, Qiu Ronggen, Ji Zhifan. Construction of Battery Recycling System Based on Subsidy Strategy--Taking New Energy Vehicles as the Object. Economics, vol. 5, pp. 69-72,March 2022.

[5] Liang Guizhen. Research on the cultivation of innovative applied talents in the new energy vehicle industry cluster under the background of service industry structure transformation. Economics, vol. 3, pp. 24-32, January 2020.

ISSN: 2692-7608 DOI: 10.6981/FEM.202208_3(8).0024

[6] Fu Yueqiang, Xia Tian. Modeling and Simulation of Electric Vehicle Industry Development Based on System Dynamics. Journal of System Simulation, vol. 33, pp. 973-981,April 2021.

[7] Mao Ling, Deng Siwen, Zhao Denghui, et al. Application and thinking of new energy vehicle monitoring platform in driving and charging scenarios. Chinese Journal of Electrotechnical Technology, vol. 37, pp. 10-14,January 2022.

[8] Xu Jianzhong, Sun Ying. Market Mechanism and New Energy Vehicle Industry Cooperative Innovation Evolutionary Game Research. Operational Research and Management, vol. 29, pp. 99-102,May 2020.