Study on Fault Diagnosis Model of Electric Vehicle based on Learning Algorithm

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Abstract. As a complex system composed of a variety of mechanical and electrical equipment, the fault of electric vehicle is also complex and diverse. The fault causes of electric vehicles have the characteristics of fuzziness or randomness. As an important part of the electric vehicle, the power battery pack is one of the main fault sources of the electric vehicle, and it is also the focus of fault diagnosis. Therefore, this paper first analyzes the battery fault of electric vehicle, and then introduces the knowledge base and classification method of fault diagnosis model, and finally studies the fault diagnosis model and algorithm of electric vehicle based on decision tree.

Keywords: Fault diagnosis model, Electric vehicle, Learning algorithm

1. Introduction
The purpose of electric vehicle fault diagnosis is to detect and diagnose the faults in the system, so as to make a correct judgment on the structure and function of each subsystem of the system. It is an important guarantee for the popularization and development of electric vehicles to diagnose the state of electric vehicle system in time, find out vehicle faults and eliminate hidden dangers, so as to ensure the normal use of electric vehicles [1]. Therefore, it is of great practical significance to study the fault diagnosis of electric vehicles. In fault diagnosis methods, fuzzy theory, artificial neural network, genetic algorithm and other methods are widely used. With the further development of fault diagnosis technology, fault diagnosis gradually realizes automation and intelligence. The fault diagnosis system based on knowledge learning can accurately diagnose all kinds of common faults, and has strong parallel computing ability and self-learning ability, so it is very meaningful to study the fault diagnosis model of electric vehicle based on learning algorithm [2].

2. Battery failure analysis of electric vehicle
As an important part of the electric vehicle, the battery failure will have a great impact on the normal operation of the vehicle, so it is also the focus of the fault diagnosis of the electric vehicle. It is an important means to diagnose the type of fault in time when the power battery group breaks down in the process of working [3].
2.1. The influence of cell voltage
Because the voltage and electric quantity of single battery cannot meet the requirements of power supply, it is necessary to form a battery group with multiple single batteries in series and parallel. Based on the learning algorithm, the cell voltage is counted, and the influence of cell voltage on cell failure rate is sorted out. Based on the historical data of battery voltage state, the membership function distribution of single battery voltage can be obtained, as shown in Figure 1 is the membership of single battery voltage.

![Figure 1. The membership of single battery voltage](image)

2.2. The influence of cell temperature
The performance of electric vehicle power battery is greatly affected by temperature, and the change of temperature will directly affect the battery capacity, internal resistance, voltage and other parameters. The capacity of power battery will increase at high temperature and decrease at low temperature [4]. In addition, the temperature also affects the SOC value of the battery. The membership degree of cell temperature under different conditions is shown in Figure 2.

![Figure 2. Membership degree of battery temperature](image)
2.3. Influence of discharge current of single cell
With the increase of discharge current in the battery, the change of electrochemical polarization will be intensified and the voltage at the battery end will be decreased. The larger the discharge current is, the higher the possibility of performance degradation is [5]. The membership degree of battery discharge current under discharge current set is shown in Figure 3. The discharge current will seriously affect the battery life and performance, and will cause permanent damage.

![Figure 2: The membership degree of cell temperature](image2)

![Figure 3: The membership degree of battery discharge current](image3)

3. Knowledge base and classification method of fault diagnosis model
3.1. Establishment of fault diagnosis knowledge base
The electric vehicle fault diagnosis system integrates the reasoning of case and rule, so as to better manage and maintain the knowledge base. The operation of knowledge base management system design is divided into three levels, as shown in Figure 4.

![Figure 4: Levels of knowledge base management system](image4)
3.2. Knowledge acquisition and reasoning methods

Knowledge acquisition based on Petri net transfers knowledge from existing sources to other forms, including the description mechanism of knowledge source and target knowledge. In the process of knowledge acquisition based on model diagnosis, target knowledge refers to the structural and behavioural knowledge that can be recognized by computer [6]. It is described in the form of correlation matrix and reachable matrix, so the problem comes down to finding a transfer tool.

4. Model and algorithm of electric vehicle fault diagnosis based on decision tree

As a specific expression of specific problems, the decision tree fault diagnosis model determines the model that can solve the problem based on the selected model structure and specific problems. The simple problem decision tree model of electric vehicle fault diagnosis is mainly aimed at simple faults, to explain the algorithm of generating fault diagnosis decision tree, and to complete simple fault diagnosis. For complex problem decision tree model, the diagnosis of complex fault. When a large decision tree is generated from a large number of fault cases, it will be applied to the corresponding pruning and rule generation algorithm. Therefore, the decision tree model of complex problems is often used in the fault diagnosis of EV battery pack.

The data transmission of electric vehicle data, battery discharge and operation status data is sent to the monitoring center in the form of network. Then the data is transmitted to the information server through the network again, where the data is received from the serial port, unpacked and stored in the database on the database server. Then the data is distributed to the monitoring station for processing. In addition, the vehicle information acquisition equipment can also store data and automatically import it into the database with the communication control system.

5. Conclusions

In this paper, based on the analysis of the causes of the failure of the electric vehicle power battery, the membership function of the failure causes is established, and then the fault diagnosis model of the electric vehicle based on the learning algorithm is applied to the failure analysis of the electric vehicle battery pack. The decision tree is generated according to the set of examples, and the correctness analysis is made. The set of diagnosis rules generated by decision tree is attached with its accuracy statistics. Through the verification of the set of examples, the rule can guide the fault diagnosis of electric vehicles correctly. The decision tree fault diagnosis model of electric vehicle can achieve good results in the analysis and application of fault cases, which verifies the correctness of the fault diagnosis model based on learning algorithm.

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