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# *Research on Electrical Data Analysis Tool Based on Intelligent Diagnosis Technology*

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***Abstract:*** With the continuous development of automotive intelligent technology, the production and manufacturing process is facing three main problems: 1) the vehicle function is gradually complicated, the number of file development is increasing, and the traditional vehicle electrical fault analysis is difficult; 2) the electrical test data is proliferating, and the requirements for message analysis and logic judgment technology are increasing; 3) the vehicle bus data is geometrically growing, and the complexity of data analysis is increasing and the cycle time is growing. The purpose of this paper is to study electrical data analysis in the context of intelligent diagnosis technology, build a set of electrical data analysis tools, use digital technology to assist manual data analysis, realize intelligent analysis of electrical system faults, and improve the fault analysis and diagnosis capability of electrical and electronic raw and manufacturing process.

## 1. Introduction

With the continuous development of vehicle informatization, the increasing electrical functions and complex electrical design logic have brought great challenges to the cultivation of electrical appliance quality. In addition to the schematic diagram, wiring harness diagram and DTC, the repair of electrical problems requires the use of complex data files such as in-vehicle network communication signals, wake-up sleep mechanism, sensor & actuator hard-wired signals for diagnosis and analysis. Faced with the continuous development of technology in the field of vehicle electrical appliances in the future, the development trend of production standards and manufacturing processes is mainly reflected in the following aspects: 1) The functions of the vehicle are complicated - with the continuous increase of development documents, the scope and content of electrical production standards continue to increase Vehicle electrical diagnosis is becoming more and more complicated. The troubleshooting points for vehicle electrical fault analysis will rise from double digits to three digits, and the traditional analysis method is difficult to deal with; 2) The electrical test data is increasing continuously - the vehicle electrical test data will increase from 100MB to GB upgrade and even TB level growth data analysis work is becoming more and more complicated, vehicle fault analysis faces more electronic control wake-up mechanism, calibration self-learning mechanism, etc., message analysis and logic judgment

technology put forward higher capability requirements; 3) Vehicle bus Geometric growth of data - vehicle monitoring data increases from 1GB-5GB to TB level or even PB level. Data analysis work is constantly complicated, similar to high-voltage interlock failure. When bus monitoring and CANoe are used to analyze bus failure, data recording, translation and the analysis period will be extended from January to February.

This paper aims to study electrical data analysis under the background of intelligent diagnosis technology, build a set of electrical data analysis tools, use digital technology to assist manual data analysis, realize electrical system fault intelligent analysis, and improve the fault analysis and diagnosis ability of electronic and electrical equipment production and manufacturing process.

## 2. Research contents

The research content of this paper mainly includes the following three parts: intelligent analysis and display of electrical data, multi-objective optimization based on machine learning and the application of data analysis tools in the existing HIL test bench.

(1) Intelligent analysis and big data display of electrical data facilitate data query and comparison, and provide visual analysis and more reliable data support for electrical fault analysis. The data intelligent analysis component of the intelligent fault diagnosis system of electronic and electrical appliances can monitor and forecast the operating parameters, operating status and other data of electrical appliances in real time through the processing and analysis of the monitoring data of electrical equipment; After injecting the electrical fault signal into the system, the system quickly gives the cause of the electrical fault and the faulty electrical equipment based on the fault prediction model, and sorts them based on the calculated probability to give business personnel maintenance suggestions.

(2) Based on the multi-objective optimization of machine learning, the decision optimization suggestions of fault analysis are given. According to the monitored electrical data, the fault prediction model is used to predict the running state of the equipment. For faulty electrical equipment / components, fault intelligent analysis tools, pre trained fault mode models of electronic and electrical systems, fault knowledge bases, electronic and electrical maintenance knowledge bases, etc. according to the logic of electronic and electrical systems, multi-objective optimization techniques (such as Pareto optimization, genetic algorithm, immune algorithm, PSO, multi gradient descent algorithm (MGDA), etc.) are used to quickly give the fault causes and faulty components, And the optimal maintenance strategy that meets the target conditions (such as the shortest maintenance time, the lowest maintenance cost, etc.).

(3) Develop data analysis tools to realize the seamless connection of existing HIL test bench data and carry out data analysis; Intelligent fault diagnosis of electronic and electrical appliances is an open fault prediction and intelligent diagnosis platform, which supports a variety of data access forms. For online device information access, the system can provide a variety of standardized API interfaces, such as rest API, soap API, SQL/NO-SQL data interface, etc. through the data interface, the device information can be quickly accessed to the fault intelligent diagnosis system for data analysis and fault prediction; In addition, for discrete data based on documents, the system also provides data extraction in common file formats, such as Excel, CSV, JSON, txt and other format data. For the existing HIL test bench data, the system can directly read the bench test data through the standardized interface, carry out intelligent analysis and fault prediction of the bench data, as well as fault analysis and decision-making.

## 3. Research route and principle

Based on the background of intelligent diagnosis technology, this paper aims to develop a set of

electrical data analysis tools suitable for the whole vehicle electronic and electrical system, and realize the following functions: intelligent diagnosis and analysis of electrical fault; Intelligent analysis and big data display of electrical data facilitate data query and comparison, and provide visual analysis and more reliable data support for electrical fault analysis; Based on the multi-objective optimization of machine learning, the decision optimization suggestions of fault analysis are given.

Intelligent fault diagnosis of electronic and electrical appliances is an open fault prediction and intelligent diagnosis platform, which supports a variety of data access forms. For online equipment information access, the intelligent diagnosis system can provide a variety of standardized API interfaces, such as rest API, soap API, SQL/NO-SQL data interface, etc. through the data interface, the equipment information can be quickly accessed to the fault intelligent diagnosis system for data analysis and fault prediction; In addition, for discrete data based on documents, the system also provides data extraction in common file formats, such as Excel, CSV, JSON, txt and other format data. For the existing HIL test bench data, the system can directly read the bench test data through the standardized interface, carry out intelligent analysis and fault prediction of the bench data, as well as fault analysis and decision-making.

According to the needs of the system for the quality and quantity of training data for building prediction models and fault analysis and decision optimization, the system supports the use of built-in / developed standard modules to build the DOE workflow of bench test cases, and automatically generate the corresponding HIL/ commissioning test condition scenarios based on the set range. The data analysis tools provided by the intelligent fault diagnosis system of electronic and electrical appliances include multiple data source data access, data analysis, data cleaning, data model development, multi parameter optimization, data display and other modules. The data extraction tool set realizes the access of online data and offline data through the data interface, and predicts the possibility of electrical equipment failure in the next 1 or 3 hours based on the monitored electrical data in real time; For possible faults or fault information that has occurred, the fault analysis model is based on evolutionary algorithm, or Pareto multi parameter optimization algorithm, and fault knowledge base to quickly give the causes of faults and faulty electrical components; In addition, based on the monitored electrical data and the electrical fault information predicted based on the model, various predefined charts in the data visualization module are used for intelligent display, such as thermal diagram, trend diagram, etc.

## 4. Technical measures for research

The intelligent fault diagnosis system of automotive electronic control domain adopts big data mining technologies such as statistical analysis and machine learning / deep learning, which are relatively mature at present, to build the intelligent data analysis, fault prediction and fault intelligent diagnosis analysis model of electrical system. According to the monitored electrical data, the fault prediction model is used to predict the running state of equipment. For faulty electrical equipment / components, fault intelligent analysis tools, pre trained fault mode models of electronic and electrical systems, fault knowledge bases, electronic and electrical maintenance knowledge bases, etc. according to the logic of electronic and electrical systems, multi-objective optimization techniques (such as Pareto optimization, genetic algorithm, immune algorithm, PSO, multi gradient descent algorithm (MGDA), etc.) are used to quickly give the fault causes and faulty components, And the optimal maintenance strategy that meets the target conditions (such as the shortest maintenance time, the lowest maintenance cost, etc.). Realize online intelligent analysis of electrical system data, dynamically display equipment operation parameters, operation status, failure probability, failure causes and identification of failed electrical components, shorten the collection,

translation and analysis cycle of electrical system monitoring data, improve failure maintenance efficiency and reduce the probability of safety accidents.

**Seamlessly connect the HIL test bench data and design the corresponding HIL/ commissioning test condition scenario:** the electronic control domain fault intelligent diagnosis is an open fault prediction and intelligent diagnosis platform, which supports a variety of data access forms. For online device information access, the system can provide a variety of standardized API interfaces, such as rest API, soap API, SQL/NO-SQL data interface, etc. through the data interface, the device information can be quickly accessed to the fault intelligent diagnosis system for data analysis and fault prediction; In addition, for discrete data based on documents, the system also provides data extraction in common file formats, such as Excel, CSV, JSON, txt and other format data. For the existing HIL test bench data, the system can directly read the bench test data through the standardized interface, carry out intelligent analysis and fault prediction of the bench data, as well as fault analysis and decision-making. According to the needs of the system for the quality and quantity of training data for building prediction models and fault analysis and decision optimization, the system supports the use of built-in / developed standard modules to build the DOE workflow of bench test cases, and automatically generate the corresponding HIL/ commissioning test condition scenarios based on the set range. As shown in Figure 1

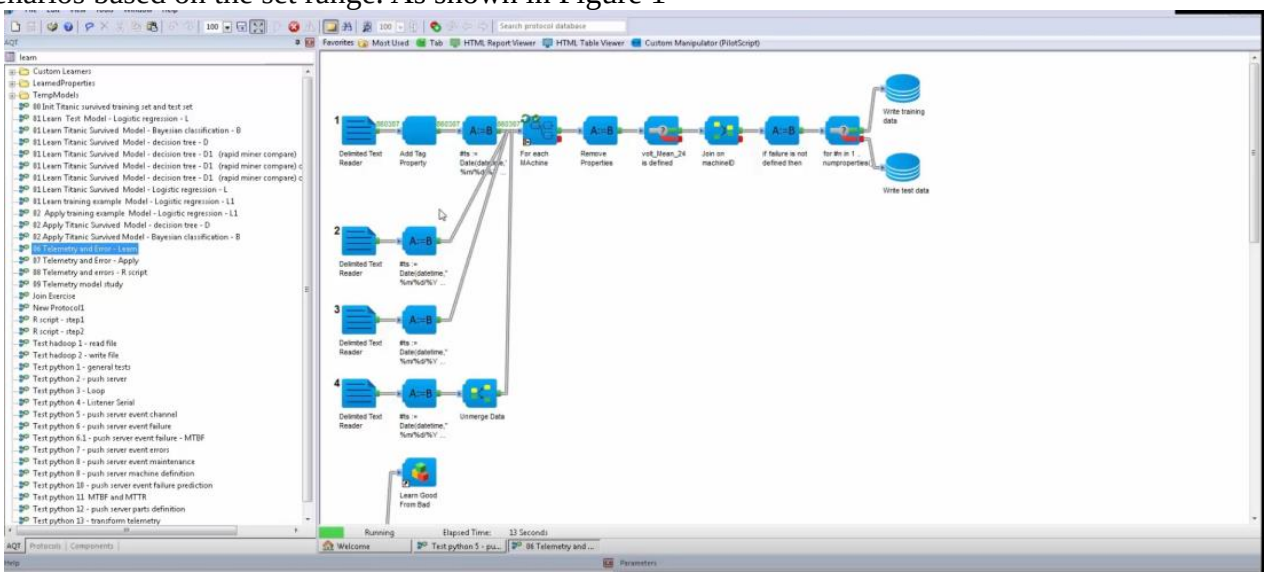

Figure 1: Demonstration diagram of data analysis module

**Fault information collection, mathematical model analysis, intelligent presentation of analysis results:** the data analysis tools provided by the intelligent fault diagnosis system of the vehicle electronic control domain system include multiple data source data access, data analysis, data cleaning, data model development, multi parameter optimization, data display and other modules. The data extraction tool set realizes the access of online data and offline data through the data interface, and predicts the possibility of electrical equipment failure in the next 1 or 3 hours based on the monitored electrical data in real time; For possible faults or fault information that has occurred, the fault analysis model is based on evolutionary algorithm, or Pareto multi parameter optimization algorithm, and fault knowledge base to quickly give the causes of faults and faulty electrical components; In addition, based on the monitored electrical data and the electrical fault information predicted based on the model, various predefined charts in the data visualization module are used for intelligent display, such as thermal diagram, trend diagram, etc. As shown in Figure 2

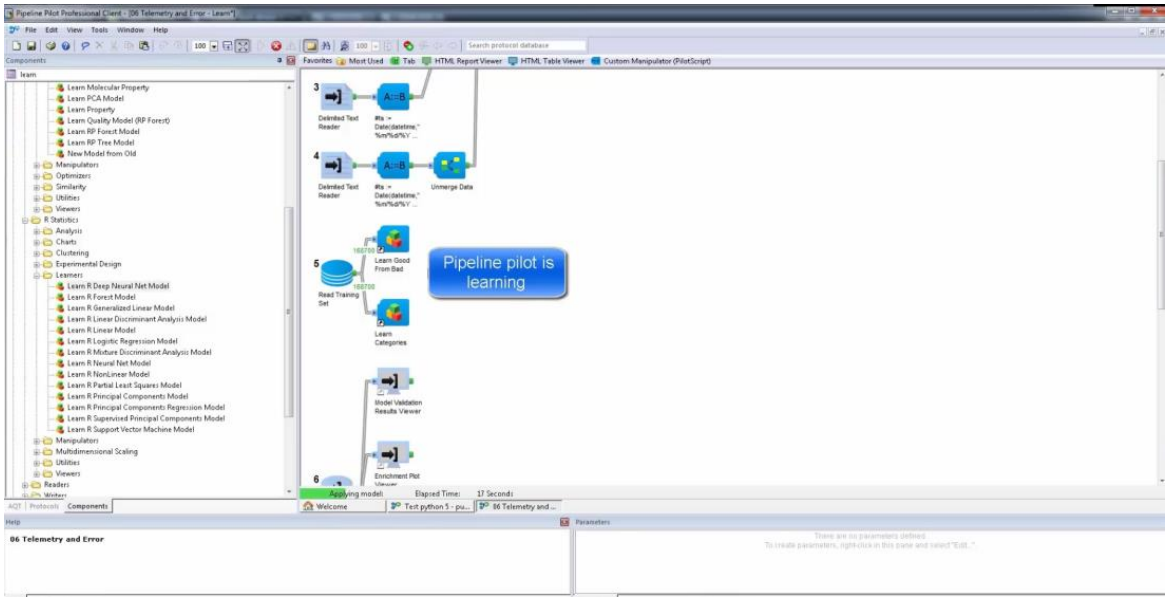


Figure 2: Demonstration diagram of machine learning module

## 5. Research findings

The results of the project have been verified in C100 models and expanded according to the relevant vehicle product data of C100 models. Through practical application, the data analysis tool can realize the automatic generation and analysis of the electrical appliance prevention and control instruction manual by up to 60%, which can save the outsourcing development cost of subsequent models by 600000 yuan / single vehicle *60%=360000 yuan / model (refer to the bidding price of D357 model), and the outsourcing cost of the complete vehicle "electrical appliance failure model" can be reduced by about 500000 yuan / single vehicle. According to two new models every year, the outsourcing cost can be reduced by 1.72 million yuan / year, and the synchronous development cost can be reduced by about 1 million yuan / year.

## 6. Conclusion

The intelligent analysis software system for electrical fault diagnosis designed and developed in this project, based on big data analysis technology, can display the data changes, the operating status of electrical equipment, the time point of failure and the cause of failure in real time for the electrical data connected to the system; Analyze the electrical equipment that fails, and find out the electrical equipment that is most prone to failure and causes the most failure information. This tool uses digital technology to assist manual data analysis, realize intelligent fault analysis of electrical system, and improve the fault analysis and diagnosis ability of electronic and electrical equipment production and manufacturing process.

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