Research on Fault Diagnosis of Telephone Network Equipment Based on Case-Based Reasoning

Wenhua Bai¹, Lihua Su¹, Feng Zhu¹, Lemeng Guo¹,*

¹National University of Defense Technology, Xi’an, 710106, China

*Corresponding author: e-mail: bwh@nudt.edu.cn

Abstract. In order to realize that the fault handing capability of telephone network equipment is not reduced due to the replacement of maintenance and management personnel, it is necessary to use information technology to realize the intellectualization and automation of the fault diagnosis of telephone network equipment. In this paper, the fault maintenance records of telephone network equipment in the operation process are digitized, and the case-based reasoning method is used to study the fault diagnosis of telephone network equipment. Through case base learning, the number and quality of cases are continuously expanded, and the reliability of telephone network fault diagnosis is improved.

Keywords: Case-Based Reasoning, Telephone Network Equipment, Fault Diagnosis

1. Introduction

Telephone network equipment is an important basic equipment in modern life. Whether it can run safely and reliably has a very wide impact on the convenience of people's life. Due to the continuous updating of maintenance and management personnel, the maintenance experience and technology of telephone network equipment are lost, and it is difficult for new maintenance and management personnel to undertake the task quickly. In order to deal with this problem, relying on the means of information technology to establish a telephone network equipment fault diagnosis system becomes the best choice. In this paper, the method of case-based reasoning and rough set are used to realize the fault diagnosis of telephone network equipment and solve the above problems.

2. The Principle and Mechanism of Case-Based Reasoning

Case based reasoning is a kind of method that uses the information or knowledge of historical cases to solve similar case problems [1]. It allows people to obtain knowledge through the study of historical cases, so as to match similar historical cases from the database, and modify and improve these historical cases accordingly, so as to draw conclusions on the current problems. This method is often used in decision-making system, expert system and so on.

The case-based reasoning system can also combine problem analysis with learning, accumulate new problems and expand case bases [2]. When reasoning a new case, first of all, input the target case
(phenomenon) into the case system in a specific way (simple or advanced), retrieve the case that is completely consistent with the description of the target case through similarity calculation, and submit it to the user; if there is no case description that is completely consistent with the description of the target case, submit the similar cases of the target case to the user according to the order of similarity degree. Through the actual adoption of users, feedback information to the case database further improve the accuracy of case diagnosis.

Thus, the core of case-based reasoning lies in the quantity and quality of case bases. With the increasing coverage of case-based reasoning and case data feedback adjustment, the effect will be better.

The flow chart of CBR diagnosis is shown in Figure 1.

![Figure 1. The flow chart based on case-based reasoning](image)

### 3. Case Presentation

The implementation of case-based reasoning is closely related to the efficiency and the design of the case presentation. Case presentation mainly involves the following questions [3, 4, 5]: First, choose what information to store in the case; Second, design appropriate case content description structure; Third, design case bases. When the number of cases in case base is increasing, the organization and index of cases become very important.

The case representation in this paper is to describe the known cases of telephone network equipment in detail as far as possible, which is composed of problem description part and solution. The case description part consists of equipment alarm characteristics and personnel observation information, such as: First, equipment alarm characteristics, including equipment model, network management prompt, fault code, equipment displayed, etc. Second, personnel observation information, packet dial tone, voice quality, communication status, etc.

Through the above feature attributes, the analysis case base can be established for the obtained telephone network equipment fault case records. Taking a device as an example, the case description is shown in Table 1, including the main features of the case.

| Describe Objects | Equipment Alarm Features | Personnel Observation Information |
|------------------|--------------------------|----------------------------------|
|                  |                          |                                  |

Table 1. The Main Factors of Target Case
5. Scheme Determination

The maintenance plan of the case is the core and focus of the system. Therefore, the improvement of the maintenance plan is a long-term and complex process. When the cases that are consistent with the similarity of the target case are retrieved, the top 10 cases are listed in the order of similarity from high to low, and the user selects them according to the description of the case. It is generally recommended to choose the top cases as the reference of the solution.

The main attributes of the target case are shown in Table 1. By searching the case database, the case information related to the target case analysis is obtained, as shown in Table 2.

### Table 2. Similar Cases

| S.N. | Equipment Type | Fault Code | The Features Prompt Tone | Communicate Status | Maintenance Program | Similarity |
|------|----------------|------------|--------------------------|--------------------|---------------------|------------|
| 1    | Access Equipment | JB01       | Subscriber Loop Fault    | User Fault         | 3021                | 2          | 4          | 4          |

4. Case Retrieval

Case retrieval and selection is the key steps of CBR system, based on the maintenance and object options include retrieval of similar cases and select [6]. The commonly used case retrieval methods are: nearest neighbor method, inductive index method and knowledge guidance method. In this paper, the nearest neighbor matching method is used to calculate the case similarity. The definition of case similarity is as follows:

\[ s(T,C) = \sum_{i=1}^{n} k_i s_i(T,C) \]  

(1)

Where T represents the target problem, C represents the retrieved similar case, \( s(T,C) \) represents the overall similarity of the case, \( k_i \) denotes the weight of the ith feature, \( s_i(T,C) \) represents the similarity of the ith feature.

Whether the weight setting is reasonable or not has a great impact on the case retrieval results. There are many methods to determine the weight, such as multi-objective optimal method, analytic hierarchy process, subjective assignment method, frequency statistics method, etc. This paper uses the survey and expert consultation method to determine the weight of case keywords manually. All the attributes of this case are divided into two categories: equipment alarm characteristics and personnel observation information. Because these descriptions belong to qualitative description, they can be directly implemented by string matching algorithm. If the text of the target problem and the case about the same attribute is consistent, the attribute similarity value is 1, otherwise it is 0.
In fault diagnosis, the case collection is to add the current fault cases directly to the case base according to the form of case representation which has no high similarity in case feature matching. New cases need to be added according to the standard. If the addition and learning of new cases are not strictly controlled, the errors of the same category in the case base will be presented in the form of multiple different cases, resulting in redundant historical cases and redundancy of the case base. In this way, in the process of case call and feature matching, the matching times will increase and the matching time will extend, which will seriously affect the efficiency of case retrieval.

6. Conclusion

In the research of telephone network equipment fault diagnosis system, equipment performance and fault characteristics are complex and diverse, which are difficult to obtain. In the description of fault features, this paper uses the equipment alarm features and personnel observation information to describe; uses the case-based reasoning method to express the case in the form of main features; uses the nearest neighbor retrieval strategy to search the retained fault features in the case base, stores the new knowledge obtained in the process of problem solving in the system case database, and analyzes the latest fault features. The application results of the final scheme are evaluated to further improve the case database and provide reference data for the next step of retrieval.

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|   | JB01 | 3021 | 2   | 4   | A1  | S1  | 0.95 |
|---|------|------|-----|-----|-----|-----|------|
| 2 | JB01 | 3021 | 2   | 4   | A2  | S2  | 0.91 |
| 3 | JB01 | 3038 | 1   | 4   | A1  | S2  | 0.88 |
| 4 | JB01 | 3051 | 3   | 3   | A2  | S1  | 0.81 |

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