Design and Implementation of 10kV Distribution Network Distribution Dispatching System Based on Eclipse Development Platform

Xin Li *
Industrial Engineering, Tianjin University of Technology, Tianjin, China

*Corresponding author e-mail: xin.li15@sc.sgcc.com.cn

Abstract. In order to meet people's requirements for power quality and distribution network reliability, a distribution dispatching system for urban distribution network based on Eclipse as the development platform, Oracle as the database and eOMP as the software support is developed. After the demand analysis of the distribution network, the functional structure of the system is determined, and the overall design and detailed design of the system are carried out. The rule base is constructed according to the operation rules of distribution lines, and the knowledge base of operation order expert system is represented and inferred by BP (Back Propagation) neural network model. The results show that the system runs reliably and smoothly. Through this system, the power grid company can compile and implement the normal operation mode of distribution network, draw a primary wiring diagram of the line, make maintenance plan, and carry out scheduling and operation management of relay protection and automation devices in distribution network. Thus, the system helps to improve the power supply capacity and reliability of distribution network and reduce its operation cost.

Keywords: distribution automation; operation order expert system; information support platform; distribution network.

1. Introduction
With the rapid development of China's economy, the contradiction between the growing demand for electricity and the weak distribution network has become very prominent. In order to improve the quality of power supply, to meet the needs of national economic development and social electricity consumption to the maximum extent, and to establish a modern power company with "one strong and three excellent", on the one hand, it is necessary to construct and reform the power grid equipment; on the other hand, it is necessary to apply advanced science and technology to improve the scientific management level of power grid production and operation.

Because of the particularity of distribution network engineering data (i.e. the correlation with geographical location), the traditional management method is mainly to manage the written data tables and line trend charts generated in the initial stage of line construction. In the development process of power industry for decades, various power departments have accumulated a large amount of distribution network paper data [1]. However, these drawings are difficult to update, the data consistency is poor,
and the manual retrieval efficiency is low. It is impossible to make a comprehensive analysis based on the stored data, which results in the lack of scientific theoretical basis for decision-making and presents a cumulative development trend [2]. Moreover, under the requirement of dealing with both massive attribute data and spatial data, the traditional relational database-based computer management system has been difficult to meet the processing requirements [3].

As we all know, power system is a large network, capital and technology intensive industry. With the general improvement of people's living standards and the growth of power supply demand, the power supply network grows day and night like a neural network and extends constantly, and the network almost covers every corner of people's life. Safe, reliable and economic power supply, changing the management concept, strengthening service awareness and providing services that satisfy users require the power supply enterprises being able to capture the increasing and increasingly complex information of power supply equipment, changing power grid information, changing urban roads and building information at any time, so as to improve the quality of employees and the level of enterprise comprehensive management [4]. In view of the spatial and temporal attributes of power grid information, it is necessary to provide complete and accurate relevant information at any time, that is, to manage and call all kinds of graphics, maps and data attributes information at any time and to realize system-wide sharing. To solve these problems, it is necessary to make use of the latest developed and mature technology, namely GIS (Geographic Information System).

2. State of the art

The management system of distribution network engineering under 10kV is studied. From the point of view of development, the information construction of power enterprises is mainly discussed. In fact, a series of actions in daily work are applied to the information software project by means of science and technology. The project achieves all the things of daily management.

Computer first appeared in the United States Department of Defense, originally used for national defense construction. After years of worldwide efforts, the computer has gradually developed at a high speed. Now it is used in all walks of life, such as office, family and so on. In the early years abroad, the production management software for electric power has been developed, implemented and achieved a certain function and production efficiency, such as ERP (Enterprise Resource Planning), life cycle management software, efficient systems, etc. [5]. In the field of distribution network engineering, it was put forward in the ninetieth generation. At that time, it was because the flow of people inside the enterprise increased the time of project approval, the internal business process of the enterprise was complex, the work efficiency could not be improved, and the whole energy could not be invested in its key business. As a result, it was trial-produced, researched and developed, and had a large amount of investment. At last, it brings high economic benefits to the power system and ensures the high efficiency and stable operation of the power system [6].

The information software construction of electric power enterprises in China has been studied and invested since the 1960s. It has been developed for a long time and has achieved certain technical results in China. For example, the early MIS system and the big marketing system have been widely used in various electric power enterprises and their subordinate departments, and these systems have made great contributions to electric power.

In the field of engineering management, research has begun since the early 1990s, mainly through three stages of development. The first stage is the application field of OA office system in 2005-2006, the second stage is the application field of 2007-2008, including OA office system, real estate management system, and the third stage is the application of 2009-2010, including OA office system, real estate management system, construction project management system, human resources management system, etc. Especially when the WEB occurs, more and more investment is put in research such as power material management system, emergency management system, ERP management system, collaborative office software and so on, which saves a lot of manpower and material resources for everyday things, and improves certain economic benefits. However, there are still some deficiencies in the existing engineering systems. For example, the compatibility, flow-based self-configuration,
automatic management of query and statistics module are not considered comprehensively, maturely, stably and the projects need to be continuously upgraded and maintained [7]. Therefore, it is proposed that distribution network engineering management at 10kV and lower should be carried out with the study of the direction of power engineering, to solve the above shortcomings. The latest mainstream computer technology and the thinking ability of programmers will be used to make up for the shortcomings of previous power failure projects [8].

3. Methodology

3.1. Expert system

Expert system is an intelligent system, which can solve difficult problems from the perspective of human thinking and way of thinking. It contains the expertise and experience of experts in specific fields, and can be reasoned and judged according to some existing conditions.

![Figure 1. Architecture of expert system.](image)

Figure 1 is the structure diagram of expert system. From the diagram, it can be seen that expert system is composed of six parts: knowledge base, inference engine, interpreter, knowledge acquisition, database and human-computer interaction. Among them, knowledge base and inference engine are the most important parts of expert system. They provide the most important support for expert system to solve problems.

3.2. Term bank

Power operation in power system has its own language, term for short. These terms are used in the process of filling out the operation sheet. When describing the operation of the switch, there are two choices: pull-up and close; when describing the switch, there are "check in open place" and "check in closed place" for selection, and it is required to fill in the front of the operation item when filling in. The operation of fuse is "mounted" and "removed", and the operation of relay is "input" and "exit" and so on.

There are different definitions of operation terms in different places. In order to make the operation order expert system be better applied to different places, the scheme of separating the term base from the rule base is adopted. This enables the term bank to dynamically match the rule base and make its own maintenance more convenient. Figure 2 is the structure diagram of the expert system for operation tickets. The operation order management module of the distribution integration system developed here realizes the operation order management system in the figure, which enables the users of the system to manage the generated operation tickets.
4. Results and discussion

4.1. Topological representation of distribution network

In the process of representation, buses, lines or transformers in distribution network are mapped to nodes in the topological graph, while switches are mapped to branches in the topological graph, so a node-branch topological graph can be obtained. Figure 3 is a typical distribution network structure.

In the above distribution network diagram, it is seen that there are four parts of distribution network equipment: power supply, switch, line and user. The letter B in the figure represents the class of switches, including circuit breakers and sectional switches. Substations and switching stations as well as buses and users are called power, and the arrow indicates the connection of users. In the process of analysis, users and power supply are regarded as nodes and switches as branches. ai j represents the connection between node i and j switch. When the value is 1, it means that the switch is closed, the nodes and branches are connected, and when the value is 0, they are disconnected. The switching states of this state are all closed, which can be represented by a matrix:

\[
A = \begin{bmatrix}
1 & 1 & 0 & 0 \\
1 & 0 & 0 & 0 \\
0 & 0 & 1 & 1 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{bmatrix}
\]

4.2. System main function architecture and system database design

The main functional framework of the system is shown in Figure 4.
Allocation of OMS

![Diagram of main functional architecture of the system.](image)

**Figure 4.** Main functional architecture of the system.

Because the table structure of the distribution network data table is not complex, the system database is generated by the table structure, and it is not designed by PowerDesigner. Here is a completed device type table DistNet.t EQUIPTYPE.

| Field name             | Type          | Is it empty? | Default |
|------------------------|---------------|--------------|---------|
| EQUIPTYPE_ID           | VARCHAR(50)  | N            |         |
| EQUIPTYPE_PARENT_ID    | VARCHAR(50)  | N            |         |
| EQUIPTYPE_CODE         | VARCHAR(100) | N            |         |
| EQUIPTYPE_NAME         | VARCHAR(100) | N            |         |
| EQUIPTYPE_CIMCODE      | VARCHAR2(50) | Y            |         |
| SG_EQUIPTYPE_CIMCODE   | VARCHAR2(50) | Y            |         |
| TABLE_ID               | VARCHAR2(100)| N            |         |
| TABLE_KEY_ID           | VARCHAR2(100)| N            |         |
| EQUIPTYPE_ISDEL        | INTEGER      | N            |         |
| CIM ID                 | VARCHAR(50)  | Y            |         |
| EQUIPTYPE_ORDER        | INTEGER      | Y            |         |

### 4.3. Functional modules after system implementation

The functional modules after the system implementation include system overview, dispatch operation, fault overhaul, emergency repair, auxiliary analysis, basic data and system management seven modules.

The system profile interface shows the current operation status of the selected power supply company, including some real-time information of each module. It shows the area covered by the distribution network, which is a result of the integration of the system and GIS. From this map, the location information of substation can be inquired intuitively. In the dispatching operation interface, it can be seen that it includes dispatching on duty management, operation order management, checking ticket management, maintenance plan management, dispatching log management, indicator point display of maintenance plan, distribution network operation statistics, and power maintenance task management.

This module is the core module of the system. When performing item-by-item operation, the operable contents are "reading", "new edition of old tickets" and "printing". When querying the item-by-item operation order query interface, fill in the query conditions and click the query button, and then the query results will be displayed on the interface. For the operation of query results, there is only "read". The reset button clears the query condition. In the ticket management interface, the management of typical operation tickets is realized. When a certain operation order is selected and the "join" button is clicked, the selected operation ticket is set as a typical operation ticket and stored in a typical operation
ticket bank. The dispatcher can call the operation order at the time of operation. The equipment management interface shows the composition of the equipment management module in the basic data module, including equipment dictionary type maintenance, equipment dictionary maintenance, plant and station management, line management, equipment type management, equipment management, dispatching single line management, substation management, switch station management and power plant management. The system management interface includes organization management, user management, team management, announcement management, interface working condition and data buffer management. There are editing, deleting, adding, downloading templates and batch importing for the operation of the organization.

5. Conclusion
The distribution and dispatching system in power system is mainly studied. Considering the characteristics of distribution automation system and dispatching automation system, and combining with the tasks to be accomplished and data transmission in actual distribution dispatching process, it decides to integrate distribution automation system with dispatching automation system, so as to make distribution dispatching work better carried out. The basic framework of the system is designed, the system design and detailed design are carried out, and the functions that each module needs to realize are defined. The technology used in system development includes development route, system development framework, selection of development platform and various development tools used in the development process.

Acknowledgements
The authors acknowledge the National Natural Science Foundation of China (Grant: 111578109), the National Natural Science Foundation of China (Grant: 11111121005).

References
[1] Dorostkarghamsari M, Fotuhifiruzabad M, Lehtonen M, et al. Value of Distribution Network Reconfiguration in Presence of Renewable Energy Resources. IEEE Transactions on Power Systems, 2016, 31(3), pp. 1879-1888.
[2] Simshauser P. Distribution network prices and solar PV: Resolving rate instability and wealth transfers through demand tariffs. Energy Economics, 2016, 54(2), pp. 108-122.
[3] Jiming C, Lizhi Q, Mingyu S, et al. Reactive power optimization for distribution network with multi-scenario wind power generator. Power System Protection & Control, 2016, 1(2), pp. 139-145.
[4] Karimi M, Mokhlis H, Naidu K, et al. Photovoltaic penetration issues and impacts in distribution network – A review. Renewable & Sustainable Energy Reviews, 2016, 53(1), pp. 594-605.
[5] Cao W, Wu J, Jenkins N, et al. Benefits analysis of Soft Open Points for electrical distribution network operation. Applied Energy, 2016, 165(5), pp. 36-47.
[6] Cao W, Wu J, Jenkins N, et al. Operating principle of Soft Open Points for electrical distribution network operation. Applied Energy, 2016, 164(8), pp. 245-257.
[7] Izadkhast S, Pablo Garcia González, Pablo Frías, et al. An Aggregate Model of Plug-in Electric Vehicles Including Distribution Network Characteristics for Primary Frequency Control. IEEE Transactions on Power Systems, 2016, 31(4), pp. 2987-2998.
[8] Zhang L, Tang W, Liang J, et al. Coordinated Day-Ahead Reactive Power Dispatch in Distribution Network Based on Real Power Forecast Errors. IEEE Transactions on Power Systems, 2016, 31(3), pp. 2472-2480.