Development of AT Traction Network Short Circuit Calculation Software Based on BS Architecture

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Abstract. In order to meet the production needs of the gradually developing electrified railway, an AT traction network short circuit calculation system based on B/S (Browser/Server) three-layer network structure is designed. Make full use of network resources, simplify the operability and arbitrariness of short-circuit calculation, and realize the timely storage and recall of data to facilitate management and statistical analysis.

1. Introduction

In 1960, our country’s first electrified railway, Baocheng Line, was completed to the present, and the electrified railway in my country has a mileage of 87,000 kilometers, with an electrification rate of about 68.2%. Electrified railway traction power supply system has experienced direct power supply (TR), BT (current-absorbing transformer) power supply, direct power supply with return line (TRNF), AT (autotransformer) power supply. Among the various power supply methods, AT power supply can not only effectively reduce the interference of the railway on the adjacent communication lines, but also have good economic and technical indicators for the traction power supply system. Therefore, it has been widely studied and widely used. In the fully parallel AT power supply mode, the failure modes are mainly short-circuit faults in the traction network and disconnection and grounding of the contact network. According to the statistical data at the fault site, the possibility of short-circuit faults in the traction network is greater, and the catenary generally does not break the wire and earth faults, but once this possibility really occurs, there may be relay failure When the electrical protection device refuses to move, the contact net loses all protection facilities due to disconnection and grounding, causing a greater accident. In order to prevent such accidents from occurring, a reasonable short-circuit calculation must be performed and appropriate equipment must be selected. This paper develops a new form of short circuit calculation for AT traction network.

2. AT power supply

Practice has proved that the AT power supply method is a relatively advanced power supply method that can effectively reduce the impact on adjacent communication lines and can adapt to the operation of high-speed, high-power electric locomotives. As shown in the figure, T is the catenary; R is the rail; F is the negative feeder. The transformer in Figure 1 is an autotransformer, one end is connected to the contact grid, one end is connected to the negative feeder, and the midpoint is connected to the rail.
In the AT power supply system, the traction side voltage of the traction substation is 55kV (2×27.5kV), forming a three-wire system of traction network of ±27.5kV and 0kV. The primary circuit of the traction network contact line and the negative feeder line connected to the autotransformer is 55kV, and the voltage between the contact network and the rail (connected to the midpoint of the autotransformer) is half of the loop voltage of 27.5kV. The two-phase balanced wiring main transformer is conducive to improving the main operation technical indicators of the substation (voltage level and negative sequence current, etc.) and improving the quality of power supply.

However, the main wiring of the traction substation is relatively complicated, which increases the investment cost of one time. It is suitable for high-speed, heavy-load and busy mainline electrified railways, especially in high-speed railway traction substations in some countries such as Europe. With the promotion and development of the new century high-speed railway in China and many countries in the world, the overall advantage of the technology and economy of the AT power supply traction substation will be further adopted.

3. AT short circuit calculation software type
The B/S three-layer network structure mode of this software uses dynamic server webpage technology and database to realize functions such as calculation and data storage in the software.

3.1. System function
Using the obtained AT traction network data, the background will obtain corresponding indicators according to the calculation formula, including overload capacity, etc. According to the value provided by the user, it is compared with the obtained data for fault analysis and line selection. At the same time, it is possible to store and call data. Due to the application of database technology, the data obtained in each calculation will be saved for future use.

3.2. System component
The development of AT traction network short-circuits calculation database software based on B/S architecture can be specifically divided into six parts: front end, presentation layer, business layer, data layer, database, and operating environment. These six parts are responsible for their respective duties and overall consideration, forming a technical framework and overall layout of the software.

(1) Front-end UI part
In the design process of the software front end, because the B/S architecture has the characteristics of convenient operation interface opening, flexible calculation, strong security, and superior to C/S structure in customer use and website maintenance, we chose based on B/S Architecture web design. Different from the traditional application (Application), the browser model of B/S architecture web design has a larger capacity and can carry more clients.

In front-end programming, HTML5 based on the new features of HTML, CSS, jQuery, DOM and JavaScript is used as the programming language. HTML5 is a language developed by W3C and
WHATWG. Write html code, optimize the page through CSS, and use it as the initial definition of the
interface.

(2) Display layer.

The display layer uses the dynamic rendering of the module engine to allow the website program to
separate the interface from the data, and the business code from the logic code, greatly improving the
efficiency of software development. Build a good page structure, analyze the layout, divide the frame,
and then plan the structure to achieve modularity. By exchanging a small amount of data with the
server in the background, as shown in Figure 3, Ajax can make webpages update asynchronously, used
for the development of Web front-end, and is a technology used to create better and faster and more
interactive Web applications.

![AJAX working principle](image)

Figure 2 AJAX working principle

(3) Business layer.

The business layer is a part of the users in the technical architecture, and the corresponding
business generation and maintenance environment, that is, the business execution node, is required on
the website. During the development of AT Traction Network's short-circuit calculation database
software, a part of the business layer is reserved for functions such as content management, user
management, system settings, system logs, data statistics, and daily maintenance. The business layer
and the data layer together form the software's log records. The presentation layer, business layer and
data layer form user identity authentication and authority control.

(4) Data layer.

The data layer is the core part of the software technology architecture and overall layout. The front
end of the data layer is connected to the user's business layer, and the back end is interconnected with
the database. The data layer is designed to perform a series of operations on the data (in this article,
the current data of the AT traction network), including data storage, data cache, custom functions, read
and write databases and other transactions. Data cache and storage, that is, to save the monitored
current data. User-defined function, that is, to realize short circuit calculation of AT traction network
through programming language. By inputting the required parameters, the results of the traction
network power system are obtained with a modular program code and the output is displayed on the
web page for the inquirer to judge according to local conditions. Read and write database, that is to
read and write to the database, store the data in the database in real time, which is convenient for data
summary statistics and monitoring.
(5) Database. In the selection direction of the database, we comprehensively considered factors such as applicability and economy, and adopted SQL Server. SQL Server is suitable for small and medium-sized websites and is an open source database. For the back end of the software, we connect the interface to the SQL Server database for entry, so that the input data can be imported and saved in time. The database can maximize the functions of data storage, addition, deletion and modification. At the same time, it can query single data, single group data, group data and entire group data. The JavaScript language is used to connect the MVC framework and the database, and the request sent through the page program. The Java program can integrate and encapsulate the data sent by the front desk, and can transfer the request data between the database and the client interface to achieve the transaction function.

(6) Operating environment. The AT traction network short-circuit calculation database software based on the B/S architecture can be applied to three different operating environments of Alibaba Cloud host, independent server, and third-party virtual host.

4. Running demonstration
According to the analysis of the power system, we added a test function to the software, that is, the power system of the Subei Institute is used as a standard to automatically fill in the coefficients and directly calculate the results. You can also enter the parameters to be tested in the corresponding parameter fields to calculate by yourself. The example here takes short-circuit current calculation as an example.
5. Conclusion
The AT traction network short-circuit calculation system is a B/S-based software designed according to the actual calculation needs of the AT traction network. Abandon the traditional technical solution, using B/S structure (Browser/Server structure), that is, browser and server structure; software calculation only needs to enter specific parameters, can be calculated on a simple webpage, and the test function can provide reference data as the sample, it has the advantages of simple operation, strong execution, and simplified calculation process.

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