Research on intelligent early warning system of rail transit line trip based on pscada

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Abstract. In this paper, an intelligent early warning scheme for rail transit line trip based on PSCADA system is proposed. The scheme takes into account the defects of low prediction accuracy and real-time prediction caused by the lack of power data in the traditional line trip prediction method. At the same time, a large number of power data generated by PSCADA system in the long-term application process are ignored in the field of rail transit[1]. Based on this situation, the prediction data set is constructed by combining the historical power data collected by PSCADA system in rail transit and the lightning weather data in traditional prediction methods. On this basis, the lightgbm machine learning intelligent algorithm is used to compare the similar support vector machine (SVM) and logistic regression algorithm to obtain a model with good prediction effect. In practical application, the real-time data set is constructed by using the real-time power data and real-time weather data collected by PSCADA system to predict, and an intelligent early warning system with the dual advantages of real-time and high accuracy is obtained.

1. Introduction

The traditional line trip prediction method is to predict the line trip probability by studying and locating the lightning occurrence area and scale and predicting the lightning weather or mountain fire disaster[2-4]. The application of this method to predict line tripping is mainly based on the important conditions that weather factors such as lightning or mountain fire affect line tripping. It is mainly to indirectly predict the tripping probability through the status and probability of lightning and mountain fire disasters. At the same time, this method ignores the power parameters generated in the process of line operation, which is of great significance, and also leads to the problem of low prediction accuracy. The PSCADA system of rail transit integrated monitoring system can collect the data of rail transit power supply system in real time[5]. If the real-time power data is used to predict the line trip fault, it will not only improve the real-time and accuracy of the prediction method, but also improve the utilization of power operation data.

2. Materials and Methods

This chapter mainly describes how the rail transit line trip intelligent early warning system proposed in this study is composed and applied to the actual operation of rail transit. This paper describes in detail how the intelligent prediction model constructs the data set, how to apply it in daily life and how to fault early warning. The flow chart of line trip intelligent early warning system is shown in Figure 1.
2.1. System introduction
In this paper, an intelligent early warning scheme of line trip based on PSCADA system is proposed. In order not to lose the characteristics of relying on Lightning characteristic prediction in the classical line trip probability prediction method, the real-time power data information and weather information obtained by power monitoring system (PSCADA system) are combined in the scheme. In this way, the line trip probability can be predicted in real time to improve the real-time performance and the utilization of power data. Combined with machine learning algorithm to improve the prediction accuracy, so as to achieve more timely and accurate early warning effect, facilitate the operation and maintenance of rail transit power supply system, reduce the loss caused by line trip fault, and improve the safety of rail transit system.
2.2. Model building
The data set used for the establishment of the model comes from the relevant historical data of Metro Transmission Lines in 2021 recorded by the system in a metro station of Shanghai line 15. The data set specifically includes the operation and maintenance data of power supply lines, the relevant data of grid line tripping faults, the status of switch blades, remote voltage and current data, etc. In order not to lose the characteristics of relying on Lightning characteristic prediction in the classical line trip probability prediction method, we add the weather data to the processed operation and maintenance data set to form a prediction model data set containing lightning and other weather characteristics. The current data, weather, wind force, high and low temperature, lightning and line tripping at the current time and the first 50 recording points are combined into the same data set. The processed data set is imported into the line trip early warning model based on lightgbm for training, and the relevant parameters of the algorithm are adjusted appropriately to obtain higher accuracy and form the final optimization model. This model is compared with the model based on traditional logistic regression and SVM (support vector machine) algorithm to prove its prediction advantage.

2.3. Application Introduction
During daily operation, we combine the real-time current data and real-time weather data collected by PSCADA system as the prediction data set, predict according to the determined line trip prediction model based on lightgbm, and output the prediction results to the fault early warning system in real time to inform the dispatcher.

The fault early warning system can realize the fault early warning function based on the HMI interface of PSCADA system, timely push and inform the dispatcher of the fault predicted by the intelligent prediction system, so as to stand out from the massive alarm information and provide efficient and intuitive alarm information and auxiliary decision-making basis for the dispatching and monitoring personnel. The original alarm information in the system shall be divided into levels and display colors according to the degree of urgency. Judge according to the fault predicted by the intelligent prediction system. If the fault is predicted to occur, push it to the dispatcher in time. It is displayed in the interface with corresponding fault level and conspicuous color. If no fault is predicted, the predicted current will also be judged. If the current exceeds the set limit, it will also give corresponding alarm, play a corresponding warning role and assist the dispatcher in decision-making.

3. Results & Presentation

3.1. Result analysis
The processed data set is imported into the line trip early warning model based on lightgbm for training, and the relevant parameters of the algorithm are adjusted appropriately to obtain higher accuracy and form the final optimization model. Compared with the traditional logistic regression and support vector machine (SVM) models, this model has obvious advantages in prediction accuracy and prediction speed. The comparison of model prediction accuracy and time consumption is shown in Table 1 and figure 2.

|                  | LightGBM | SVM  | LR     |
|------------------|----------|------|--------|
| Accuracy         | 0.9167   | 0.75 | 0.6667 |
| Time consumption | 0.018    | 0.032| 0.054  |

Table 1. Accuracy and time-consuming of each model in predicting fault conditions.
At the same time, when there is no tripping fault in the prediction result, the intelligent prediction model can be further used to predict the telemetry current. If the predicted current exceeds the set limit, the corresponding alarm will be given. Table 2 and Figure 3 show the comparison of measurement accuracy and time-consuming of the model.

|        | LightGBM | SVM  | LR  |
|--------|----------|------|-----|
| Accuracy | 0.833    | 0.75 | 0.833 |
| Time consumption | 0.036 | 0.07 | 0.099 |

The above chart shows that this prediction model has certain advantages in prediction accuracy and prediction speed, whether in predicting line trip or fault current.

3.2. Application result display
The results predicted by the intelligent prediction model are output to the fault early warning subsystem. The alarm information will be divided into levels and display colors according to the set emergency degree, and displayed in the interface with the corresponding fault levels and colors. The effect of early warning system is shown in Figure 4.
4. Conclusions

This paper studies the rail transit line trip intelligent early warning system based on PSCADA system, and draws the following conclusions:

1) The intelligent early warning system of rail transit line trip based on PSCADA system effectively makes up for the defect that the traditional method cannot predict in real time, and provides an idea for improving the real-time performance of line trip prediction method;

2) The prediction model of rail transit line trip intelligent early warning system based on PSCADA system has certain advantages in predicting line trip and fault current.

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