Research on the Overcrossing Alarm Method and Device in an Electric Power Place

Jianyu Li*, Runbo Lu*, Ke Zeng, Huaxi Huang*, Hongbiao Lun, Yifan Hu

No. 1 Substation Management Office of Dongguan Power Supply Bureau of Guangdong Power Grid Co., Ltd
Dongguan, China
*Corresponding author: Jianyu Li, Runbo Lu, Huaxi Huang

Abstract: Near-power operation in substation is an important means of operation and maintenance of power equipment. There is a risk of electric shock in the field operation of personnel, so the real-time monitoring of the operation site and the alarm of personnel cross-boundary behavior play an important role in the electric power safety production. This paper mainly studies a cross-crossing alarm method and device in an electric power site. It collects operator and device data, calculates safe operation probabilities, and uses intelligent mapping to detect boundary violations. The system selects an appropriate alarm strategy based on these probabilities and spatial data. It aims to enhance the accuracy of risk detection while minimizing false alarms, thereby improving safety in power operations. The technical scheme provided in this paper realizes the detection of transboundary risk by integrating multiple attribute information, and improves the correct alarm probability of transboundary risk when reducing the false alarm rate of transboundary risk.

Keywords: near-power operation; cross-line alarm; detection device; alarm strategy

1. Introduction

In the process of substation operation in power places, it is difficult to guarantee the safety of operators due to the complex environment, numerous live equipment, uncontrollable range of activities, different safety awareness of operators, and whether the operators can wear safety protection tools correctly. Therefore, in the process of operation tasks, the timely warning of threatening the safety of operators [1] can effectively protect the life and property safety of operators.

In the existing technology, the safety protection mode for operators has the traditional physical fence mode, including pulse electronic fence, infrared electronic fence, intelligent pulse electronic fence, tension electronic fence and other virtual fence technology [2-6]. In addition, a positioning sensor can be set on the object to detect the position of the object based on the image sensor, and then the object position status data obtained by the sensor for security protection. However, the disadvantage of the existing technology is that the data obtained by the sensor is often limited. In addition, if the sensor fails or the sensitivity is not high or the accuracy is not high enough, it is easy to produce false alarm, which makes the detection efficiency of the boundary behavior threatening the safety of the operators low.

This paper provides a method of boundary alarm to realize the detection of boundary risk and improve the correct alarm probability of the false alarm risk. [7]

2. Principle of Overcrossing Alarm Method in Electric Power Place

During the execution of the job tasks, To obtain the personnel attribute information of the operator collected by the detection device and the device attribute information of the detection device, And obtain the operation attribute information of the operation task from the substation management system; Determining the safe operation probability of the operator according to the person attribute information, the device attribute information and the job attribute information [8]. Based on the mapping relationship between the safe operation probability and the candidate alarm strategy [9, 10], Determine the target alarm strategy for the operator, And based on the pre-constructed power site intelligent map and the spatial information of the operator to determine whether the operator has crossed the boundary; If the risk of crossing is detected, Then the alarm is made based on the target alarm strategy.

3. Composition of Crossing Alarm Devices in Power Places

A cross-boundary alarm device in a power site is composed of an attribute information acquisition module, a operation probability acquisition module, a cross-boundary condition judgment module and a cross-boundary alarm module.

(1) Attribute information acquisition module is used to obtain the personnel attribute information of the detection personnel and the device attribute information of the detection device during the execution of the operation task, and to obtain the operation attribute information of the operation task from the substation management system.

(2) The job probability acquisition module for determining the safe operation probability of the operator according to the person attribute information, the device attribute information and the job attribute information.

(3) The transboundary condition judgment module is used to determine the target alarm strategy for the operator according to the mapping relationship between the safe operation probability and the candidate alarm strategy, and to determine whether the operator crosses the boundary based on the pre-constructed intelligent map of the power site and the spatial information of the operator;

(4) Cross-crossing alarm module for alarm based on the target alarm strategy if the operator crossing risk is detected.

4. Specific Implementation Method of Cross-Crossing Alarm Method in Electric Power Site

The specific implementation of cross-crossing alarm method in power places is analyzed as follows:

1. During the execution of operation tasks, obtain the personnel attribute information of the operators of the detection device and the device attribute information of the detection device, and obtain the operation attribute information of the operation task from the substation management system.

Specifically, during the task execution, the personnel attribute information of the operator, and the personnel attribute information of the operator can be obtained through the substation management system, then sending the personnel attribute information of the operator and the detection device to the cloud server, that is, the personnel attribute information of the operator and the device attribute information of the detection device can be obtained through the cloud server.

Among them, the substation management system can be an integrated information management system for monitoring, controlling and managing the operation of power substations. Can control transformer, switchgear, including controlling switchgear closing situation, adjust transformer voltage and current and other functions. At the same time, the maintenance, overhaul and operation of substation equipment, including operation planning and scheduling, operation record, operator qualification management, operation and equipment association and other functions. The personnel attribute information can be at least one of the face information, the cumulative working time of the operator, the operation time, the location information of the operator, the wearable carrier phase difference technology (Real-Time Kinematic, RTK) positioning device ID (Identity Document), the location information is the actual geographical location information refers to the longitude, latitude and height of the operator in the operation process. Moreover, the embodiment of the present invention does not restrict the acquisition mode of the operator location information, the category of the operator personnel attribute information and the specific acquisition method. In addition, the device attribute information of the detection device may be at least one of the available state of the detection device, the available type of the detection device, and the wearing position of the RTK positioning device of the operator, without the embodiment of the present invention. Specifically, the available state of the detection device means whether the detection devices in the detection device can function normally, such as whether the camera can transmit video normally; the available type of the detection device refers to the type of the detection equipment currently working normally, such as an infrared detector. Among them, the operation attribute information for the operation task obtained from the substation management system can be at least one of the operation type, the total number of workers, the expected operation area and the estimated operation period. The embodiment of the present invention does not limit the operation attribute information of the operation task obtained from the substation management system.

It should be noted that before the operation task, the operator should input the operation task information including operation type, total operation number, expected operation location and expected operation period into the substation management system. In particular, the substation management system can interact with the cloud server through the communication unit. Cloud server after receiving the job type uploaded by substation management system, the total number of jobs, expected operation location and expected operation period of information, can according to the received information to determine the personnel of the personnel, the cumulative working time, the safety awareness of at least one, and the confirmed information stored in the cloud server. Among them, the nature of the personnel includes senior operators, intermediate operators and junior operators, in particular, the safety awareness of the operators is positively correlated with the nature of the personnel, that is, the higher the level of the personnel nature of the operators, the higher the safety awareness, the embodiment of the present invention does not limit this.

When the detection device detects the operator, the personnel attribute information of the collected operator and the detection device attribute information can be uploaded to the cloud server through the communication unit. In particular, when the detection device tests the operator, it is the test of the wearable RTK positioning device, as shown in Figure 1. When the present invention embodiment tests the operator, the selected detection method is not restricted. In determining the identity information of the operator, the personnel attribute information can be collected according to the detection device, for example by the image video recording device, or the ID of the operator by the wearable RTK positioning device, the embodiment of the present method of the operator identity information is not limited. After obtaining the operator identity information, at least one of the personnel nature, cumulative working hours, and security awareness of any operator may be determined based on the cloud server, which the embodiment of the present invention does not limit.

In the process of operation task execution, the personnel attribute information of the operator and the device attribute information of the detection device that are collected by the detection device are obtained, as well as the operation attribute information of the operation task is obtained from the substation management system, and

then the information collected from different aspects is integrated to carry out the follow-up work.

Figure 1. Schematic diagram of the target personnel trajectory route.

2. Determine the safe operation probability of the person attribute information, the device attribute information and the job attribute information.

Specifically, the safe operation probability of the operator can be determined according to the obtained personnel attribute information, device attribute information and operation attribute information. Among them, the determination mode of the safe operation probability of the operator can be determined by a function model or by deep learning (Deep Learning), and the embodiment of the present invention does not limit the determination mode of the safe operation probability of the operator.

Specifically, the safety operation probability of the determined operator may be a specific value or a scope, and the embodiment of the present invention does not limit the final presentation form of the obtained safety operation probability.

According to the personnel attribute information, device attribute information and operation attribute information, the safety operation probability of the operators is determined, so as to determine the safety of the operators in the operation process according to the safety operation probability of the operators, so as to carry out the follow-up work according to the safety operation probability of the obtained operators.

3. According to the mapping relationship between the safe operation probability and the candidate alarm strategy, determine the target alarm strategy for the operator, and determine whether the operator crosses the boundary based on the pre-built intelligent map of the power site and the spatial information of the operator.

Specifically, based on the determined safe operation probability of the operator, the target alarm strategy for the operator can be determined according to the mapping relationship between the safe operation probability and the candidate alarm strategy, and then determine whether the operator crosses the line based on the pre-built intelligent map of the power site and the spatial information of the operator.

Among them, the candidate alarm strategy can be related technical personnel set at least one warning strategy, to distinguish the different degree between at least one alarm strategy, the candidate warning strategy and safe operation probability between the mapping relationship, that is, for specific safety operation probability or safe operation probability for a specific interval, there are corresponding candidate warning strategy. In addition, the target alarm strategy can be understood as the corresponding alarm strategy selected according to the determined safety operation probability based on the mapping relationship between the pre-built safety operation probability and the candidate alarm strategy. In particular, the candidate alarm strategy includes at least one of the alarm notification mode, alarm level, alarm processing process, automatic response, and control function. Among them, the alarm notification mode can be telephone reminder, SMS reminder or alert reminder; the alarm level can be determined according to the safety operation probability, such as primary alarm, secondary alarm, etc.; the alarm processing process may be associated with the candidate alarm probability, that is, the corresponding alarm processing process is different; the automatic response and control functions can automatically execute the alarm processing process included in the candidate alarm strategy, so as to realize automatic response and perform corresponding control functions. In particular, unlike the location information of the operator described in step 1, the spatial information of the operator is determined according to the location information of the operator. The spatial information of the operator in the intelligent map of the power site, in which the intelligent map can be understood as a three-dimensional (3-Dimension, 3D) map, which is not equivalent to the existing map. Therefore, in this paper, the location information of the operator is not equivalent to the spatial information of the operator. In order to avoid repeating it, it is hereby explained here.

It should be emphasized that as the personnel attribute information of the operator and the device attribute information of the detection device change, the corresponding safety operation probability will also change, and the corresponding target alarm strategy will also change. The example can be that the change of weather information, the change of the working area of the operator, and the change of the live equipment in the working area will all lead to the change of the corresponding safety operation probability, and then the corresponding target alarm strategy will also be adjusted. Among them, the change of the live state of the live equipment in the operation area can be understood that the live state of different live equipment is in real time adjustment and dynamically change due to whether it is in the working state. Therefore, the live state of different live equipment in the operation section is uncontrollable. It is understandable that when different live equipment are in the live state, their power levels are different. Therefore, as for the live equipment in the working state, in order to ensure the safety of the life around them, they should be

moved within a certain safe distance, so the safety distance of different live equipment is different.

It should be noted that the mapping relationship based on this study is based on the mapping relationship between the safety operation probability and the candidate alarm strategy. When determining the target alarm strategy of the operator, the determination method can be to establish the mapping relationship between the safe operation probability and the candidate alarm strategy in advance, and then to determine the corresponding target alarm strategy according to the mapping relationship between the two. In addition, the smart map of electric power sites can also be pre-constructed. In particular, there can be various ways to determine whether the operator crosses the line based on the pre-built intelligent map of power sites and the spatial information of the operators.

According to the mapping relationship between the safety operation probability and the candidate alarm strategy, determine the target alarm strategy for the operator, and then determine whether the operator cross the line based on the intelligent map and the space information of the safety of the operator and the space information of the operator, so as to avoid the occurrence of safety accidents and ensure the life and property safety of the operator.

4. If the risk of operators crossing boundaries is detected, the alarm will be conducted based on the target alarm strategy.

Specifically, if the risk of the operator is detected in the operation process, the life and property safety of the operator in the current task execution process is threatened, so the relevant operators can be alerted based on the acquired target alarm strategy.

When the risk of crossing boundaries is detected, the operators can be alerted based on the target alarm strategy to reduce the occurrence of safety accidents and improve the safety of the operators in the process of operation task execution.

5. Summary and Outlook

In conclusion, this paper presents a boundary-crossing alarm method and device for electric power sites, which integrates operator and device data to calculate safe operation probabilities and employs intelligent mapping to detect boundary violations. The system enhances risk detection accuracy and minimizes false alarms, thereby improving operational safety. However, the study acknowledges limitations in real-time data processing and the adaptability of the system to varying environmental conditions. Future work should focus on refining data analytics and expanding the system's environmental adaptability. Additionally, incorporating advanced sensors and machine learning algorithms could further optimize alarm strategies. The future development prospects of this research lies in its potential to integrate with smart grid technologies, offering a comprehensive safety management solution for power system operations.

Acknowledgement

The research was funded by: Project No.: 031900KZ24040083; Project name: 3D Visual Intelligent Safety Management Device for Substation.

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