Research and Application of Smart Lock Safety Management and Control System

Song Wei1,2
1NARI Group Co, Ltd. Nanjing 210061, China
2Nari Technology Development Limited Company Nanjing 210061, China
Huadiansongwei@163.com.cn

Abstract. The total number of switch stations and distribution stations in the distribution network has increased year by year; overhead lines have been gradually cabled to the ground; the number of ring network cabinets and box-type transformers has increased rapidly. The distribution network equipment has the characteristics of "small, large quantity, and decentralized", and it is difficult to manage. For a long time, problems such as theft, unauthorized unpacking operations, and unauthorized private operations have been troubling distribution network operation managers, affecting the safe and stable operation of the distribution network and reliable external power supply. The intelligent lock safety management and control system proposed in this paper is based on the actual situation of the power distribution network, and replaces the original mechanical lock with an intelligent lock. The system implements real-time effective management and control of the production operation process and status of power distribution equipment through the "authorized unlocking" of the handheld terminal. At the same time, it implements information and visual management of equipment, staff and related information, so that distribution network managers can play the role of "master". This system can manage and control the power distribution equipment, and improve the operation and management level of the power distribution network.

1. Introduction
With the development of the economy, the process of urbanization is accelerating, and the total number of switching stations, switching centers, and distribution stations in the distribution network has increased year by year. Both quality and quantity are rapidly increasing [1,2]. The construction and management of urban distribution networks are playing an increasingly important role in a strong smart grid.

At present, indoor equipment such as power distribution rooms, switch rooms, and outdoor equipment such as ring cabinets, box transformers, and cable branch boxes in distribution networks have been locked with mechanical padlocks or mechanical key locks for safety protection and the purpose of anti-theft, but the effect is not ideal, because the security management problems brought by locks have not been well solved [3].

At the same time, the substation gradually changed from conventional to intelligent, from manned to unmanned, and has basically realized the comprehensive perception of the important links of the whole station and the centralized monitoring of the background. Good solutions, safety accidents caused by unauthorized change of work place or expansion of work scope occur from time to time [4,5]. In order to solve the above problem of mechanical latching, this article proposes a smart lock security management and control system. The smart lock has the characteristics of high security and
convenient operation, which can greatly improve the security of distribution equipment, the simplicity of personnel operations, and improve operation and maintenance. It has high efficiency and can carry out equipment operation and maintenance analysis and personnel trajectory analysis according to the intelligent lock operation record to help the power grid construction. The following table is a comparison table of mechanical locks and smart locks.

Table 1. Comparison table of mechanical locks and smart locks

| Contrast item                        | Traditional mechanical lock | Smart lock                      |
|--------------------------------------|-----------------------------|---------------------------------|
| Key ratio                            | Greater than one to three   | Thirty to one                   |
| Key management method                | Manual management           | Centralized or decentralized management |
| Method of using the key              | Get it out of the box and return it the same day | Object, frequency, and time period hierarchical authorization management |
| Unlock mode                          | One-to-one                  | One-to-many authorization to unlock |
| Unlock record                        | Artificial paper records    | Automatic recording in the background |
| Temporary emergency unlock           | Return to the management office and re-acquire the corresponding key or mechanical lock | Apply for a new authorization online |
| Lost key operation                   | Mechanical damage, skid lock | Reauthorize new key to unlock |
| Key leakage risk                     | The unlock function is still valid | Clear authorization, unlock function is invalid |
| Background management system         | No                          | Provide data reports, data statistics, data analysis |

2. Key technology

2.1. Wireless energy-carrying communication technology

Wireless cooperative communication is a new type of wireless communication. Unlike traditional wireless communication, which only transmits information, wireless energy-carrying communication can transmit energy signals to wireless devices while transmitting traditional information-type wireless signals. Energy signals are After the wireless device capable of the circuit receives, after a series of conversions, the wireless energy can be stored in the battery of the wireless device itself. The captured energy will be used for the energy consumption of the normal information interaction circuit of the wireless device and the energy capture circuit Energy consumption. With the use of wireless energy-carrying communication technology, the cost of wires and cables can be reduced, and the trouble of replacing batteries for wireless devices can be avoided.

In this paper, wireless energy-efficient communication technology is used to complete the power supply and data exchange of the terminal within 3s, improve the convenience and reliability of the operation, and effectively shield the external high-voltage impact and damage.

2.2. Access Process Control Strategy

By deploying control policies on the smart lock security management and control system and equipment, access and control authority authentication is realized, which improves system operation security, equipment control security, and information transmission security.
2.3. System dynamic password authorization
The smart lock security management and control system uses operation requests combined with the hash calculation of the background service to generate dynamic passwords to implement authorization operations, to achieve more secure user operation management and control, and to solve the traditional problem of ineffective supervision.

3. System structure

3.1. System structure
The system consists of three main parts, including a smart lock security management system, a handheld terminal, and a smart lock. As the main control unit, the smart lock security management and control system implements basic data management, geographic positioning, authorization management, and statistical analysis of data. The handheld terminal implements mobile office for smart lock management, approves switch lock applications of staff at any time and place, and checks the security status of equipment within the scope of responsibility and the performance of personnel's work. Smart locks include padlocks, handle locks, door locks, etc. The locks have high mechanical strength and strong corrosion resistance. Fully sealed RFID coding is used to make each lock have a unique code to ensure high security of the lock.

![System architecture of smart lock safety management and control system.](image)

3.2. Authorization method
(1) Active authorization for fault repair
When the power distribution network fails, the intelligent lock management system enables active authorization. The smart lock management and control system receives the fault interval analyzed by the fault analysis and analysis, and analyzes the ring network cabinets and power distribution rooms involved in the fault. The smart lock management and control system pushes messages to the smart
lock control mobile terminal, including the authorized smart key valid time and equipment. The maintenance and repair personnel use the intelligent lock to control the mobile terminal to perform the unlocking operation and complete the collection to close the lock. Smart lock control mobile terminal records, uploads unlock and close lock records to the smart lock management and control system. Show as figure 2. Flow chart of active authorization for fault repair.

(2) Authorization method of daily operation inspection

In the daily operation inspection authorization method, the smart lock control terminal is applied for smart key authorization through the smart lock control handheld terminal. The relevant personnel of the smart lock security management control system review and approve the application submitted by the smart lock control handheld terminal. If the approval is passed, the smart lock is notified. The handheld terminal has been authorized. If the approval fails, the smart lock will be returned to the reason why the handheld terminal failed. After the approval is passed, the maintenance personnel will open the lock with the smart lock-controlled handheld terminal, the maintenance is completed, the lock is closed, and the smart lock handheld terminal uploads the switch lock operation to the smart lock management and control system. Show as figure 3. Flow chart of authorization method of daily operation inspection.
Figure 3. Flow chart of authorization method of daily operation inspection

4. Conclusion
The research and application of the intelligent lock security management and control system solved the problems of numerous keys, easy to lose, and difficult to manage distribution network equipment; this standardized the distribution network operation process, improved work efficiency, and saved repair time. The system completed Data query, data analysis and management recommendations according to different filtering conditions, which improve the monitoring and management level of distribution network operations.

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