Street View Inspection System of Distribution Network Based on GIS

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Abstract: With the reform of electric power system and the gradual expansion of power grid scale in different cities, the traditional inspection method has been unable to adapt to the power transmission in the new era, and there are many defects in the system, especially in the extreme weather conditions, the power patrol inspection work is full of difficulties. This paper mainly studies the design and implementation of the street view inspection system of distribution network based on GIS. The key technologies of power patrol system are analyzed, including geographic information system (GIS), global positioning system (GPS), C/S network structure and database technology. Secondly, according to the actual situation, the detailed design of the inspection system is made on the basis of GIS. It includes the design of the overall architecture, the division of functional modules and the design of the corresponding database. Then, the design and implementation of the mobile terminal patrol APP was completed, and the main functional interface of the system was finally displayed.

Keywords: Geographic Information System, Power Inspection, Global Positioning System, Inspection System

1. Introduction

The inspection of power lines is the daily work to ensure the safe and stable operation of power transmission lines and power facilities related to power transmission lines. By line inspection can find hidden trouble in security transmission lines and transmission equipment, transmission lines and operation of the power facilities and the change of the surrounding natural environment, so that you can quickly eliminate is easy to cause the defects of equipment failure, so as to prevent accidents, to minimize the risk of the failure of transmission line and the target. With the rapid development of economy, the electric power industry, as an important pillar of the national economy, is also developing rapidly, and the demand for modern management of electric power enterprises is also
raised to a new height. On the one hand, the continuous construction and development of the power grid has led to the continuous expansion of the scale of the power grid, and the corresponding number of transmission, transformation and distribution equipment has also increased significantly compared with the past. These factors have greatly increased the difficulty in the inspection and inspection of power lines and power equipment [1]. The inspection system based on GIS is different from the traditional integrated inspection system, which can make the inspection work hierarchically and systematically by presetting the priority according to the frequency of line fault and assigning the optimal route to each line to be inspected. This new working mode saves labor cost and brings higher economic benefit for electric power enterprises. For the inspectors themselves, the work burden is reduced and work efficiency is improved.

Overseas research on power inspection system is relatively early, mainly focusing on substation inspection. More advanced inspection methods include video surveillance inspection technology, helicopter inspection technology, hd image recognition and the latest uav inspection technology. In order to achieve highly automated UAV patrol work, Kilic combines image processing, target recognition and tracking, GPS positioning and other technologies with UAV patrol power line, and develops a set of navigation system that can be used for UAV patrol based on the characteristics of installation and installation of transmission line insulator and other equipment. Considering the situation that the UAV needs emergency landing, such as insufficient energy, the system also designs the emergency landing scheme and puts forward the safe landing algorithm. Finally, experiments verify that the system can effectively achieve the goal of uav high autonomous safety patrol [2]. In order to reduce the cost of transmission line inspection, Tokura developed a uav high-voltage transmission line inspection system that can be mounted with photoelectric detection equipment and realize visual analysis and automatic navigation [3].

With the rapid development of computer technology, communication technology and network technology, the working mode of electric power inspection is constantly changing, which tends to be informationized, automated and intelligent. In order to cope with the common problems in the traditional inspection process, GIS technology is integrated into the inspection system to meet the actual work needs through continuous investigation and practice.

2. GIS Based Inspection System

2.1. Inspection System Requirements

(1) Characteristics of the patrol inspection system

The intelligent reform of power grid puts forward higher requirements for the inspection work. The inspection work of power grid is no longer just a simple independent work at fixed time and fixed point. The new intelligent inspection way should take into account the real-time load of the whole power grid, the service life of equipment and other factors, and make overall arrangements for the inspection task. It is assumed that a group of equipment in the system is operating under high load or full load during the peak period of power consumption. In this case, the frequency of inspection of the equipment should be appropriately increased to prevent the overload operation from affecting the service life of the equipment and reduce the probability of failure [4-5]. The task of inspection will be directly downloaded to the mobile terminal of inspection through the network while reaching the
management department of the production line, which puts forward new requirements for the business capacity of electric power enterprises.

(2) Inspection process

The circuit inspection process is as follows:

Make the line patrol plan. According to the annual, quarterly and monthly work plans, as well as special tasks such as power protection, the line inspection plan shall be formulated. According to the requirements of relevant regulations, the transmission lines of 35kV and above shall not be less than once a month, and the transmission lines of 10kV and below shall not be less than once a quarter.

Arrange circuit inspection and maintenance work. Prepare relevant equipment and materials in advance according to the patrol inspection plan and the task arrangement of line defect elimination and rectification work, carry out relevant responsibilities for the task arrangement, and complete the deployment of patrol work with the planned time as the axis.

Download the task. Through the Internet network, from the PC management system to download the line patrol task to patrol the mobile terminal.

Hand-held mobile terminal field patrol inspection. GPS function of mobile terminal can be used to locate the position in the process of patrol inspection, and the situation of field patrol inspection, including patrol line, line and equipment defect, defect elimination, etc., can be recorded in the mobile terminal of patrol inspection.

Patrol data upload. After the inspection, the relevant information of the inspection will be uploaded to the database of background management system through Internet network.

Information synchronization. Using the Intranet of the enterprise, the data of line patrol inspection is published in the network platform. Staff can check the inspection time, inspection path, defect status and equipment operation status of inspectors through different access rights in any network terminal.

Analyze the results. The dedicated personnel with senior authority can analyze the problems according to the inspection information provided by the inspection personnel, record the defects found in the inspection, and contact the maintenance personnel to eliminate the defects. If the defects are still existing after the elimination of defects, the work plan and tasks for elimination shall be compiled [6]. Patrol Normal route continue to carry out daily patrol according to the regular patrol plan.

2.2. System Architecture and Modules

(1) Overall architecture of the system

The inspection system as a whole is divided into two subsystems: mobile terminal inspection system and PC terminal inspection management system. The design adopts the C/S (client/server) network structure, establishes the LAN in the whole working scope, and selects the appropriate hardware platform and software platform respectively for the patrol mobile terminal and the patrol system server. For the geographic data of lines and equipment, patrol inspection records and work data
of inspectors in each period, the database is designed to realize information query, work task and work report formulation.

The business process is described as follows: First, the production and technology department of the enterprise makes relevant inspection plans. Different inspection plans correspond to different transmission lines and related power equipment, and each inspection focuses on different areas. After the completion of the inspection plan, the inspection task will be issued through the MIS system. The inspectors will download the inspection task from the mobile inspection terminal and input the line and equipment related information according to the contents of the inspection task. At the beginning of the inspection, the system will automatically list the corresponding inspection items, and the inspection personnel will start the inspection according to the inspection items listed in the system and input relevant data. After the inspection, the equipment state will be changed to "inspected already", and then the inspection personnel will upload the inspection data to the PC management system. After all the equipment to be inspected has completed the inspection, the status of this inspection task will become "completed" [7-8]. If some equipment defects are found during the inspection, you need to wait for the instruction of elimination and contact the maintenance personnel for elimination. The inspection data uploaded to the PC management system can be searched, analyzed and counted at any time.

(2) System function module

The mobile terminal inspection system and PC terminal inspection management system in the whole GIS power inspection system have their respective function modules to realize the corresponding functions.

The inspectors download the inspection task through the mobile terminal and upload the inspection situation to the server database through the network so as to complete the inspection task.

The mobile terminal inspection system is divided into the following modules: basic data module: the name or job number of the inspection personnel, and the initial entry of the geographical information of the inspection objects. Patrol inspectors or other users authenticate with user name and password, log in to the mobile terminal of the system to determine the relevant operations, and record the patrol data of the user. Managers of advanced permissions can also add, delete, and modify user passwords.

Inspection module: The inspection module realizes map rendering, navigation of inspection routes, GPS positioning, inquiry of inspection work records and historical inspection records, and inspection of equipment and route information. GPS positioning function is implemented by mobile equipment integration, inspection personnel positioning in the benchmark or new line tower positioning and daily inspection tasks need the support of the function, the inspection personnel arrive new tower or the tower in need of inspection, click on "start checking" button, will checking mobile terminal by GPS positioning for the current position, and the current position in the interface of GPS coordinates, including longitude, latitude and time information [9].

Information transmission module: Information transmission module is to complete the data exchange between mobile terminal inspection system and PC terminal inspection management system; Mobile terminals upload work records and inspection results and download inspection tasks [10].
module is to upload the data information in the mobile terminal of patrol inspection to the server through wireless communication mode and Internet transmission mode, and then the data will be transferred to the PC management system and database.

Tool module: Contains notepad to record non-built-in defect types as well as additional important information. This module also includes the prompt sound setting, which can remind the task to be checked. At the set time point, the device will automatically emit "didi" prompt sound to remind the inspectors of the important matters or special faults and defects to be dealt with.

(3) System correlation formula

\[ f = \frac{a-b}{b} \]  \hspace{1cm} (1)

\[ e = \sqrt{a^2 - b^2}/a \]  \hspace{1cm} (2)

\[ e' = \sqrt{a^2 - b'^2}/b \]  \hspace{1cm} (3)

3. Implementation of GIS Patrol Inspection System

3.1. Development Environment

With the upgrade of Android system, most models on the market now use versions of Android6.0 or above. Considering the compatibility problem, this system chooses to develop based on Android6.0.

3.2. System Function Realization

(1) User page

The user page is mainly divided into login page, password modification page, geographic information entry page and tower inspection page. The pole tower inspection page is the main page used by inspectors during their work. After the map is loaded, the page marks its position on the map, and the pole tower position to be inspected is also marked.

(2) Main page

When a user logs in, the system determines whether he is an administrator or a worker. If it is an administrator, all functions are loaded; If it is a worker, the add and remove staff functions are blocked. During the login process in the previous step, the server returns a Boolean field of type "isAdmin" that determines which functions will be loaded.

(3) Geographic information login page

The business logic is relatively simple, user name, latitude and longitude of the geographic information of the input, choose equipment after click submit, system discrimination have null first, and then determine whether the longitude and latitude in the effective range, confirm the input information will pop up after legal AlertDialog dialog, prompt the user really determine to submit, click ok, if the network is available, the connection to the server to write information into the database.

(4) Patrol page
This business is the core business, the realization process is more complex. Users can check their real-time location in the MapView control, and the list of poles to be inspected will also be sent to the phone through the server, which will be parsed in the system and then visually displayed on the map. Click events are set for each pole tower. Click into a WebView after a tower, it can view the tower of the specific information and have a "start checking" button, click finish after the inspection, the inspection information sent over the network to the server, the server returned to send successful information, system, after receiving the tower "start checking" button is grey and not click, according to "have inspection".

4. Application Effect of GIS Patrol Inspection System

4.1. Statistics of Lightning Fault Detection Effect of Different Inspection Modes in A City

Table 1. Statistics of different inspection modes in July

| Voltage | Frequency | Regular pattern | GIS Inspection |
|---------|-----------|----------------|---------------|
| 110kV   | 9         | 7              | 9             |
| 220kV   | 8         | 5              | 7             |
| 500kV   | 4         | 3              | 4             |

Figure 1. August different training model test statistics

As shown in Table 1 and Figure 1, statistical data of the high incidence of lightning strikes in July and August in City A are selected for comparative analysis. It can be seen that in July, lightning faults were found 21 times in A city, 15 times in the conventional inspection mode and 20 times in the GIS inspection system. In August, there were 19 lightning strikes, 14 in the conventional inspection mode and 16 in the GIS inspection system. The fault detection accuracy of the tour inspection system based on GIS reaches 90%.

4.2. Statistics of Lightning Fault Detection Effect of Different Inspection Modes in B City

![Image of Figure 1]
Figure 2. Different inspection models detect fault statistics in B city

As shown in Figure 2, lightning strikes occurred 11 times in July in B city, failures were found 7 times in the conventional inspection mode, and failures were found 11 times in the GIS inspection system. In August, a total of 10 times of faults were found, 6 times in the conventional inspection mode and 9 times in the GIS inspection system. The fault detection accuracy of GIS patrol system is 95.2%.

4.3. Dynamic Security Detection Application

Table 2. Application effect of routine inspection and GPS inspection

|                  | length of the line | Inspection time | Inspection way | Power outage time |
|------------------|--------------------|-----------------|----------------|-------------------|
| Regular pattern  | 10km               | 5.2H            | Power outages  | 6.8H              |
| GIS Inspection   | 10km               | 2.6H            | Constant electric | 0H                |

As shown in Table 2, the comparison between the two inspection modes shows that the use of GIS line inspection mode can ensure uninterrupted power supply, while the length of inspection time is high, and the inspection efficiency is high. The conventional inspection mode must cut off the power when necessary. The inspection time is long and the inspection efficiency is low. The application of GIS line inspection can not only reflect the technical advantages, but also save the inspection cost and economic loss caused by power failure, so the application effect of GIS line inspection system is significantly better than that of conventional transmission line inspection system.

5. Conclusion

This paper presents a transmission line inspection system based on GIS. This inspection system takes the position coordinate of GIS as the equipment symbol, uses the mobile terminal to locate the personnel, and finally monitors the whole inspection process in all aspects through GIS management software, so as to realize the real-time transmission of relevant data in the inspection process. If defects are found in daily inspection work, the defects should be timely improved, and relevant data should be synchronized to the database of the background management system after the inspection, so as to reduce the frequency of problems. While realizing the electronic intelligence and standardization of the time system, an effective management platform should be provided for the relevant personnel of the inspection and inspection system.

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