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Transmission Line Digital Information Management System

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Abstract

Overhead transmission lines and their transmission pole towers have special geographical locations, complex operating environments, multi-faceted operation and maintenance work points, and problems involving complicated tasks, and there are a large number of lines and comprehensive inspection projects every year, and the on-site investigation efficiency is low. In order to solve this problem, this paper introduces an immersive transmission line digital information system that can support the functions of positioning navigation, online ranging, recording real-time temperature and abnormal situation alarm, and briefly introduces the database interaction, VR development and the establishment of three-dimensional models of poles and towers.

Keywords

Transmission Line Management; HTC Vive Device Development; 3D Modeling of Pole Towers.

1. Introduction

In the power system, power line inspection is a very heavy and very important work, overhead transmission lines and their transmission towers have a special geographical location, complex operating environment, operation and maintenance work points are multi-faceted, involving a wide range of tasks and other issues, and there are a large number of lines and comprehensive inspection tasks every year, the efficiency of on-site investigation is very low. The exploration cycle of the whole section is too long, and the manual exploration puts forward extremely high requirements for manpower, material resources, financial resources, etc., and the realization cost is high, resulting in a serious waste of social resources. At the same time, the maintenance operators can't be accurately controlled, and troubleshooting can't be positioned in time, so it is difficult to meet China's growing demand for power development by using manual inspection methods for maintenance of transmission lines.

Secondly, there is still no good solution for the operation, maintenance and maintenance of transmission lines in China at this stage. There are mainly the following problems[1]:

1) The transmission distance is long, and manual exploration puts forward extremely high requirements for human, material and financial resources, and the realization cost is high, resulting in a serious waste of social resources.

2) UHV transmission towers are mostly sparsely populated or even lofty, the on-site exploration efficiency is very low, the exploration cycle of the whole section is too long and there are potential safety hazards.

3) The survey method of the existing technical support can only be confirmed at a certain point in time, and cannot be real-time.

4) The maintenance situation of the maintenance staff cannot be accurately controlled.

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Based on the above problems, this paper combines the characteristics of power operation and maintenance and the operation and inspection requirements of transmission lines, and studies a digital information management system for transmission lines, which represents the location of each pole and tower in the transmission line, and uses this information to further standardize the management of power facilities and maintenance work.

2. Research Content and Implementation

2.1 Research Content

On the basis of fully understanding the background and significance of the project, the project aims to design a digital information platform for transmission lines based on offline maps, mainly to achieve the following four functions.

1) Establish a transmission line route path corridor. The on-site investigation of traditional comprehensive inspection projects is mainly to confirm the scope of power outages required for construction operations, retained live parts, the location of the installation of grounding lines, adjacent lines, conditions across and work sites, the environment and other dangerous points affecting operations, and select reasonable technical measures, organizational measures and safety measures. Due to the existence of a large number of lines and comprehensive inspection projects every year, personnel are divided and sent out for on-site investigation, while UHV transmission lines usually have tens of hundreds of kilometers and complex and changeable terrain, long transmission distance, manual inspection of manpower, material resources, financial resources are put forward extremely high requirements, can not guarantee that every base tower is surveyed, it is easy to make mistakes in the formulation of safety technical measures, information transmission process caused by omissions and so on. The tower data collected by GPS is sorted out according to the spatial topology of the trunk, sub-branch and branch of the distribution line, and according to the radial relationship of its spatial topology, the drawing of the line is completed through the orderly connection of the pole tower, the position of each base pole tower is established, and the diameter is formed in turn to form a more systematic company transmission line path diagram. Equipment information, line information and terrain information are managed by the database, that is, to achieve the unity of spatial data and attribute data, and to ensure the rationality, integrity and sharing of the data structure through the linking and association of related data, thereby eliminating the redundancy of the data and ensuring the integrity and consistency of the equipment ledger. It solves the problems of tower positioning of transmission lines, the number of poles and towers is difficult to manage, the geographical distribution is wide, the equipment installation location and geographic information are tight, and the maintenance is difficult, and the management of the pole tower combined with satellite imagery is accurate and scientific, which is of practical significance to the construction of "digital power".

2) Construct a 3D transmission line model. For the computer, the data source it can directly obtain is only a two-dimensional flat image, and there will undoubtedly be a certain degree of information loss relative to the real three-dimensional scene, so the use of two-dimensional images to reconstruct three-dimensional objects will inevitably become a key issue. In practical work, the same object is imaged separately from different angles, and then the data is analyzed and synthesized to recover the three-dimensional information of the subject, and the image-based modeling can generate an accurate three-dimensional geometric model of the object. The system will be high-definition satellite remote sensing image processing into a negative, and then the diameter and other data import can form a two-dimensional terrain, cross-sectional map and line model[2], the import of elevation data can be converted to generate three-dimensional terrain and line model, can clearly show the line topography and crossover and other situations, and each base pole tower can be entered into the data required for line maintenance, can enable operators to complete the site survey "without leaving home".

3) Create a dedicated offline map. Electronic maps that support functions such as positioning and navigation are a type of GIS that have most of the functions of a geographic information system[3]. Electronic maps can display digital signals (including digital signals formed after visual processing

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of digital maps, remote sensing digital images and self-digitized data) and analog signals on a computer screen.

4) Combined with VR technology for development. In the power system, in order to improve the technical level of the staff and improve the safety and stability of the operation of the power system, it is necessary to systematically train the staff. However, due to the particularity of the power system, it is impossible to use real equipment to train the staff, so we combined with the HTC vive equipment, through in-depth research on plug-ins such as SteamVR and VRTK, developed and established an immersive transmission line information digital platform, which can meet the simulation training needs of power system staff and assist in transmission line operation and maintenance work.

2.2 Research Content

2.2.1 Database Development

In practical engineering applications, large amounts of real-time working data are transferred to the software platform through databases. The use of three-dimensional modeling technology to establish a multi-dimensional database of lines and pole towers, the use of databases to establish an Internet of Things platform, so that the operation and inspection personnel can provide transmission line name, number, number of circuits, design meteorological conditions, pollution area and other line attributes, all transmission pole tower three-dimensional solid model, specific tower positioning coordinates, elevation, insulator metal string three-dimensional entity and various attribute information, as well as conductor, ground wire type, structure, safety factor and control guide, ground wire frame line various attribute information. For the lines that have completed the drawing data, the parameter information such as the tower, elevation, angle, distance, and insulation string type in the tower schedule can be combined to record and update the maintenance trajectory of each time, the defects eliminated by the maintenance, and the maintenance resume can be established to achieve rapid reference and call on demand.

In order to simulate this work, we use the SqlServer database simulation to establish a database to record real-time temperature and tower information, to achieve the software alarm function for abnormal temperatures and the tower information query function, and based on the experience and foundation of the above-mentioned database, in the actual engineering application process, other important data information of overhead transmission lines can be realized and alarm functions.

For lines with incomplete as-built drawings, the coordinates such as the structure and tower can be collected through field data collection, handheld GPS, etc., and the file system plus the relational database is used to form the basic database of the system, the attribute data of the system is managed by the relational database, and the spatial data of the system is managed by the file system. Considering the special requirements for spatial data query, display and analysis in 3D GIS, it is necessary to optimize the file system that manages spatial data in various forms.

In this system, we use development software for unity and VSstudio and SqlServer, and the language we use is SQL, that is, structured query language, the standard language for relational databases, and its functions include data query, data definition, data manipulation, and data control. When working on database setup, we first create a basic table by building an SQL file and add integrity constraints to the table, including entity integrity: add a master code constraint, a non-null constraint, and a custom integrity: uniqueness constraint, and add a check statement to restrict the table format. Secondly, when the data is operated, the data is modified and increased by using the update statement and the insert statement, and the temperature and tower data are imported[4]. At the same time, when interacting with unity in the database, we configure SqlServer, enable the relevant IP addresses of the TCP/IP protocol in the database, and query its ports, realize the interconnection between SqlServer and unity, and develop unity on this basis. During development, database-related development functions are encapsulated to enhance the readability and efficiency of the program. Finally, the prepared C# file is mounted on the corresponding object, which realizes the function of database data query and abnormal temperature alarm, which is convenient for auxiliary staff and other equipment to carry out line maintenance work in engineering applications.

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2.2.2 HTC Vive Device Development Combined with Unity Software

With the development of science and technology, VR technology has been widely used in engineering practice. In the power system, in order to improve the technical level of the staff and improve the safety and stability of the operation of the power system, it is necessary to systematically train the staff. However, due to the particularity of the power system, it is impossible to train the staff with real equipment, so we have developed an immersive transmission line scene simulation platform in combination with HTC vive equipment, and combined with TOOLS such as BIGMAP map and SqlServer database for offline map secondary development.

In order to facilitate user operation, we have conducted in-depth research on plug-ins such as SteamVR and VRTK, and used C# language programming combined with ray inspection, script monitoring, data iteration and other ways to achieve convenient and fast switching of transmission line scenarios. In addition, combined with transmission line GIS technology, map latitude and longitude information and unity scene world coordinates, the ranging function between any two points in the offline map can be realized. Secondly, according to the database knowledge that has been mastered, the database is connected to unity, and then the table data in the database is imported into the unity text box, and finally the alarm threshold is set by using the knowledge learned in the professional course, which can realize the alarm function of abnormal temperature. Of course, other detection data in engineering applications can also be imported using the same method to enrich the content of the project and improve practicality.

The real pole tower model was introduced, and the transmission line pole tower design professional course was used to reasonably design the entire pole tower line of the project, and the working situation of the line pole tower could be observed at close range[5,6].

Figure 1. Transmission pole tower model

2.2.3 Combined with 3D Modeling of Pole Towers

When loading offline maps, using BIGEMAP to download remote sensing images, the high-definition satellite remote sensing images become negatives after software processing, and then import data such as walking paths to form two-dimensional terrain, cross-sectional maps and route models, import elevation data can be converted to generate three-dimensional terrain and route models, and then load them into the selected 3D topographic map, and finally complete the effect of offline loading of 3D pole tower topographic maps, mainly relying on loading map data in the form of API interface documents. And through 3Dmax modeling to complete the purpose effect.

When the tower model was established, we optimized the previous tower model, corrected the position of some angles, deleted and reconstructed the unreasonable tower structure. At the same time, borrowing the fitting drawings, the Creo software was used to complete the establishment of all the fitting models required for the pole tower, including insulated hammers, jumper strings, bottom line

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overhang strings, etc. The fitting string model is shown in Figure 2. The final fittings were installed on the corresponding tower model according to the correct position relationship and matching, that is, the establishment of the tower model was completed[7].

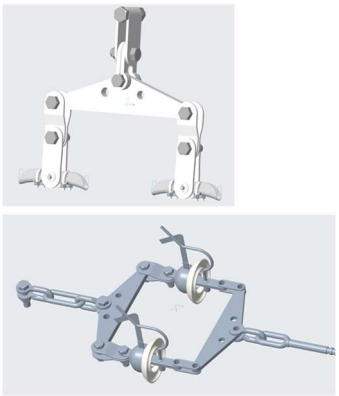

Figure 2. Fitting string model

When fitting the line, as the first generation of simulation software based on UHV transmission line, the line data has a certain level of confidentiality for the power company, in order to simulate an UHV transmission line as much as possible, for the relative position of the pole tower, the choice of route, in the actual development of the corresponding latitude and longitude, elevation value, and the corresponding data under the Cartesian coordinate system, corresponding to the corresponding heading, pitch, corresponding in the code development process based on the CESIUM library, roll viewing angle parameters, etc.

3. Conclusion

At present, long-distance electric energy transmission mainly uses overhead transmission lines, which undertake huge electric energy transmission, and the safe operation of overhead transmission lines is closely related to the stability of the power grid, and operation and maintenance work is particularly important. This article introduces an immersive transmission line digital information system that can support the functions of positioning navigation, online ranging, recording real-time temperature and abnormal alarms. At the same time, the system is developed in more detail in three aspects: database connection interaction, the use of unity to achieve VR equipment development, and the establishment of a three-dimensional model based on tower information. With the rapid progress of society, science and technology plays an increasingly important role in people's lives, I believe that in the future, transmission line management will develop in the direction of intelligence, let us wait and see.

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