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Three-dimensional high-efficiency and high-precision modeling of transmission line towers

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Abstract: *At present,three-dimensional models of domestic high-voltage transmission line towers mostly rely on professional modelers to refer to the corresponding design parameters and use CAD software to create manually.The workload is large,time-consuming and laborious, and it is difficult to meet the needs of rapid digital modeling of high-voltage transmission line corridors. To this end, a component-based modeling method for the three-dimensional model of the transmission tower is proposed to satisfy the modeler's rapid and high-precision three-dimensional reconstruction of the transmission tower.By decomposing the existing three-dimensional models of different types of power transmission towers, a full-element component model library of power transmission towers is established, so that different components in the model library can be automatically spliced according to their fixed connection relationships.When modeling a specific tower, the user only needs to specify the type and height parameters of the transmission tower, and perform the model direction and the width of the tower head.Fine-tuning can obtain a high-precision three-dimensional model of the transmission tower. This method can reduce the difficulty of three-dimensional modeling of transmission line towers, improve the modeling efficiency, and meet the engineering application needs of rapid digital modeling of power line corridors.*

Keywords: *Transmission lines; poles and towers; three-dimensional reconstruction; high precision*

1. Introduction

In order to ensure the safe operation of the power grid, the power operation unit needs to regularly inspect and maintain the power lines and facilities under its jurisdiction. In the past, this was a very difficult task. Not only was the cost high, but also the cycle was long. Especially for those transmission lines that crossed the steep mountains, the engineering was more difficult[1-2]. However, with the development of modern surveying and mapping technology, the inspection of transmission lines and related facilities has become easier and easier [3]. Using aerial photography, laser scanning and other technical means, not only can quickly obtain transmission lines in a large area detailed spatial data and attribute data of the road [4-6], and three-dimensional modeling can be used to realize the visual management and analysis of the transmission line corridor environment [7]. The transmission line corridor environment is mainly composed of multiple elements such as transmission lines, towers, surrounding features, and landforms. Under the trend of refined and intelligent management of the power grid, the high-precision three demand for three-dimensional modeling has become increasingly strong [8].Among them, ground features and landforms are the main research objects in the field of surveying and mapping, and their three-dimensional modeling technology has gradually matured [9], and the automatic three-dimensional vector modeling method for transmission lines is currently Some scholars discuss it [10]. From the perspective of application, the modeling efficiency of transmission towers has become a constraint to the entire transmission line corridor environment.

The main factor to improve the efficiency of 3D modeling.At present, three-dimensional models of transmission line towers at home and abroad mostly rely on professional modelers to refer to the corresponding design parameters and use CAD software to create manually. It is highly professional, heavy, time-consuming and laborious, and it is difficult to meet the needs of rapid digital modeling of high-voltage power line corridors[11-12].In order to reduce the difficulty of 3D modeling and improve modeling efficiency, this paper proposes a component modeling method of 3D model based on transmission line tower design and construction specifications and actual work experience to solve the problem of non-professional modelers.Problem of rapid and high-precision three-dimensional reconstruction of poles and towers.

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2. Modeling method

Since the design and construction of all transmission line towers must strictly refer to specific tower type standards, and most of the tower feet and the tower heads of similar towers have extremely high similarities, digital modeling of power line corridors is being carried out Can pass the standard model is reasonably decomposed and flexibly assembled to realize the component modeling of the three-dimensional model of the transmission line tower. This method can minimize the workload and difficulty of work while improving the reusability of the model. The construction of the component model library is the key to the tower component modeling. On the basis of comprehensively considering the differences and similarities of the three-dimensional models of different towers, this paper decomposes the transmission line tower model into two parts, the tower head and the tower foot, and carries out the component model creation and model library organization and management respectively.On the one hand, the CAD software is used to High-precision three-dimensional modeling of different components; on the other hand, the spatial relationship between different components is recorded and maintained to meet the automated splicing requirements of tower component models. The tower head is the most different part in the three-dimensional model of the tower. Its geometric form, the number of tower arms and the arrangement of the tower arms are directly related to the design type of the tower. In the process of building the component model library, it is first necessary to perform geometric modeling of the tower heads involved in the entire network or specific lines according to the design and construction standards of the line towers. Except for more complicated tower head structures such as turrets and transposition towers in some locations where the direction of power lines changes greatly, common high-voltage power transmission tower heads mainly include three forms: stem type, wine cup type and cat head type. ; Among them, the cathead towers have small changes in the arms of the tower, while the number of arms of the first two towers corresponds to the number of phases and directions of the power lines, which can be divided into one-phase, two-phase and three-phase towers and one-way and Two-way pole tower, as shown in Figure 1.

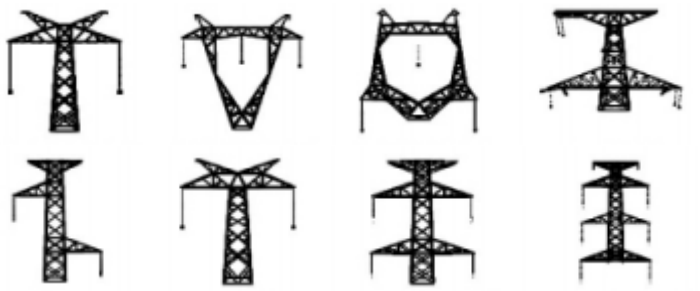

Figure 1. Tower head classification and component model library construction

3. Experimental verification

Taking an actual high-voltage transmission line of the power grid as an example, the component-based modeling method is used to reconstruct the three-dimensional model of the high-voltage transmission tower. The basic data used in the experiment is the airborne laser point cloud data obtained by the UAV-borne laser scanning system, and its ground resolution is 15-20 points/m2. Through point cloud filtering and classification, the point cloud data corresponding to all the towers along the transmission corridor can be obtained. According to the point cloud aggregation characteristics and spatial distribution, the approximate spatial coordinates are calculated and all the poles and towers on the line are modeled as a modular three-dimensional model based on this. In the modeling process, the tower type selection, height parameter setting, spatial position and direction parameter adjustment are all completed through human-computer interaction, and real-time feedback is adopted by visual means to ensure the accuracy, efficiency and precision of the tower model construction, as shown in Figure 2. Shown.

Figure 2. Tower modular modeling

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4. Conclusion

The component modeling method proposed in this paper is more of a technical framework. Its core idea is to decompose the tower into several core components, which are independently modeled and assembled flexibly to improve the reusability of the 3D model. While reducing the difficulty of modeling the line tower, it fully improves the overall modeling efficiency. Through actual engineering experiments, we have fully verified the effectiveness of this method. At the application level, the fineness of component decomposition is a technical issue that needs to be further explored in the component-based modeling method. Considering the balance of efficiency and quality, this paper decomposes the tower into two basic components, the tower head and the tower foot, in order to realize the efficient modeling of most towers. However, in order to further improve the accuracy and flexibility of 3D modeling, so that the modular modeling method can meet the efficient modeling of more complex special-shaped towers, you can also try to decompose the pole tower into tower body, tower arm, porcelain bottle string, and fittings. And other smaller structural parts.

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