Research on Multi-source Data Fusion of 3D Scene in Power Grid

Biao Zou¹, Heping Wang¹, Xiangxian Zhou², Wendong Jiang² and Wei Du¹

¹State Grid General Aviation Company Limited, Beijing, 102209, China
²State Grid Zhejiang Electric Power Company
Email: 274132887@qq.com

Abstract. With the rapid development of information technology, 3D panoramic technology has been more and more widely used, and it has played a role in urban planning, power grid engineering design, and geological analysis. This technology can provide people with a variety of scene information intuitively and realistically. With realistic space simulation scenes, users can feel a sense of immersion. Due to the different types of geographic information and related data involved, it is necessary to use the idea of data fusion and combine data from different spaces to achieve information fusion, thereby improving the accuracy of geographic information in design scenarios and better promoting 3D panoramic technology in urban planning, Widely used in power grid design, community management and other fields.

1. Introduction
The development of virtual reality technology has greatly promoted the construction of virtual campus and digital campus. Immersive browsing is more convincing than simple publicity. There is a big difference between the independent interaction of the 3D panoramic campus and the traditional passive viewing. Experts in the education sector pointed out that the development of new technologies will also bring us new ways of thinking, new ways to solve problems, and major changes in the construction of campus digitalization. Especially in science and technology research, virtual campus construction, virtual teaching method exploration, virtual experiment opening, etc., all bring huge opportunities.

Virtual reality technology can be widely used in many fields such as military and digital campus scenes. The following is a brief introduction to several main application areas. Military aspect. In the past, soldiers were trained in actual combat in military exercises in various countries. However, such actual combat exercises are not only expensive but also low in security. In recent years, with the application of virtual reality technology in the military, the concepts and methods of exercises and training have taken a qualitative leap. In the field of aviation. The United States began to study virtual reality technology in the 1980s and applied it to astronaut training. Architectural design and urban planning. Using virtual reality technology systems, architects can see and even "touch" their design results, and can easily modify them at any time, such as changing the height and color of the building. In terms of digital campus scenes, digital 3D panoramic campuses are more intuitive, vivid and real than traditional 2D campus web pages. Those who have not been to the campus can only imagine the scene of the campus in their minds, but now, the 3D panoramic virtual campus reproduces the natural human environment of the campus on the Internet, so that users can fully understand the school's teaching facilities, teaching environment, classrooms, Libraries, scientific research equipment, laboratories.
In order to build a high-precision panoramic 3D platform, a single data source can no longer meet the needs of the project. Relying on existing high-tech surveying and mapping equipment such as airborne Lidar, airborne mobile measurement system, and aviation drone can collect relevant data, while high-precision airborne Lidar data and high-resolution satellite remote sensing data assist the UAV Distance photogrammetric data and airborne vehicles.

Spatial data is obtained in different ways, so there are differences, in order to integrate multi-source data. In the data preprocessing stage, in order to ensure the accuracy of the data, it is necessary to convert the multi-source data into unified coordinates, and select the appropriate coordinate conversion model and data adjustment model according to the range and size of the data collection area. In order to achieve this registration and better fusion of multi-source data, we must first solve the transformation of the spatial geodetic coordinate system, and convert the collected diverse data with multiple coordinate systems into a unified coordinate system; second, to solve the vector For the problem of inconsistent data projection, a unified projection transformation is performed on the acquired multi-source vector data; finally, a projection analysis conversion model is established, and a high-speed geometric correction model is constructed by numerical methods to ensure that the multi-source data has a uniform application standard.

2. The Proposed Methodology

2.1. Point Cloud and Optical Image Data Rapid Matching Technology.
Since point cloud data has limited ability to reflect actual targets, it is necessary to fuse point cloud data and image data, and obtain the correspondence between point cloud and line camera lines through time synchronization. Then, starting from the spatial position, the pixels corresponding to the laser points on the scan line are obtained. Finally, read the corresponding image file and read the corresponding pixel value, and then assign the pixel to the corresponding spatial location point. This can enrich the spectral information of the color of the point cloud data. Point cloud data combined with color attribute information is more intuitive in visual display, automatic classification and intelligent modeling, and has great advantages.

Airborne lidar can obtain terrain data of buildings and small and medium-sized areas. The main focus is on the ground, the top surface of buildings and other targets. The on-board lidar can accurately obtain three-dimensional data of roads and surrounding environments, such as vegetation and other targets. Therefore, the comprehensive utilization of airborne lidar and vehicle lidar data fully demonstrates the different advantages of the two data sources and expands the spatial and temporal resolution.

Taking the vehicle lidar data as the research object, the building floor contour is extracted. The edge information (edge line) of the building facade is another important feature of the building. Assuming that most buildings are perpendicular to the ground, then these buildings are the surface edges of the plane projected as the outline of the building floor.

The outline of the building reflects the important characteristics of the building and is the key to the three-dimensional reconstruction of the building. Based on the vertices of the airborne lidar building and the corresponding image data, the top vector outline vector of the building is extracted, and the region growing algorithm is used to segment and extract the mountain-shaped roof and the complex roof.

Since the DEM data will be affected by the observation method, processing method and environment during the acquisition process, the data quality usually cannot fully meet the application requirements. In the process of data processing, there are problems of gaps in the data and vertical plane differences. The surface elevation data can better restore the actual effect, and through the improved bilinear interpolation algorithm, the gap caused by multi-source data splicing can be eliminated. This method improves the accuracy of DEM data, and at the same time uses the idea of data fusion to effectively improve the quality of the data and meet the application requirements of elevation data.
2.2. Virtual Reality Technology.
Virtual reality technology integrates computer simulation technology, remote sensing technology and other sensory simulation technologies, and interacts with virtual environment objects through computer input devices to create a realistic three-dimensional virtual reality environment. This technology has achieved great success and changed people's lifestyles.

Virtual reality technology can combine the city's surface data and terrain data, and use three-dimensional scenes to display to the user, so that the user can be immersive, interact with the user and experience an interactive immersion, and get a comprehensive experience of sight, hearing and touch.

The immersive experience can be understood as an existential experience, so that the user is immersed in a virtual three-dimensional scene to obtain a better sensory experience.

Interactivity is another feature of virtual reality technology, which means that in a virtual environment, users can experience interaction with objects in the virtual environment, breaking the original barriers. Users no longer passively accept information, but can actively participate in it.

Realistic virtual environment is the research focus of virtual reality technology. Realizing high-resolution scenes and a better interactive experience is a key element of virtual reality technology. In order to achieve this purpose, when constructing a three-dimensional scene, geometric modeling technology is used to realize the construction of a three-dimensional panorama.

2.3. Image-based Panoramic Modeling.
With the continuous development of virtual reality technology, people's demand for realism of 3D scene modeling is increasing day by day. In order to better simulate the three-dimensional scene, image-based three-dimensional modeling technology is produced. This technology has improved the defects of traditional graphic modeling to a certain extent. The three-dimensional image reconstruction technology can be used to build models based on pictures, and complete the modeling in a human-computer interaction manner, thereby improving efficiency; in addition, this technology can also give color information of corresponding objects, making the model more vivid and specific.

Image modeling uses directly captured images to reconstruct the scene, avoiding the shortcomings of traditional geometric modeling and saving a certain amount of manpower and material resources. According to different application scenarios, the accuracy and structure of the three-dimensional model can be adjusted, and the information richness can also be optimized and perfected.

Based on various characteristics of 3D panoramic images, 3D panoramic images have extremely wide applications. At present, digital 3D panoramas have been used in many fields such as virtual campus construction, tourism landscape display, commercial product display, real estate display, hotel display, car display and so on.

In 3D modeling, first of all, you need to preprocess the acquired image data, including noise reduction, and eliminating useless pictures. Second, you need to match the feature points of the image...
to accurately extract the feature points in the matching image, so as to ensure subsequent calculations; finally camera calibration and matrix calculations, and then meshing the data to visualize the 3D scene.

Image feature points are points with distinct characteristics in the image. It is usually different from the neighborhood points in properties such as brightness, color, curvature, or texture. For example, corner points, line intersections, discontinuities, and the maximum curvature point on the contour. The feature point extraction technique is to detect and describe the points in the image that have attribute differences with the neighborhood points. The selected feature points should be obvious, easy to extract, and have enough distribution in the image. In order to uniquely identify the requirements of each feature point and subsequent feature point matching module, a small neighborhood of the feature point is often selected as the center point, and a description sub-vector of the feature point is generated according to a certain measure.

Feature point matching is to find a special feature point formed by projection of a 3D field of view in an overlapping field of view in two two-dimensional images. A high-dimensional vector is used to describe feature point matching. Therefore, it is generally used between two feature vectors. The distance of several miles describes the similarity of two feature points. The two pairs of feature point pairs with the smallest and the second-smallest Euclidean distance are called the nearest neighbor and the second nearest neighbor respectively. Therefore, the feature matching problem is essentially a problem of searching for the nearest neighbor in a high-dimensional space. The simplest method of feature point matching is to use the exhaustive method to find the nearest neighbors of the matching feature points in the feature point set. However, the exhaustive method has a large time cost, and a mismatch occurs when there is no corresponding matching point in the feature points to be matched. Lowe is based on the phenomenon that the Euclidian distance between the correct matching vectors in the high-dimensional space is generally significantly smaller than the Euclidean distance between the wrong matching vectors. The ratio between the nearest neighbor distance and the second nearest neighbor distance is used to determine whether the correct match point is effectively reduced. The probability of occurrence of the above mis-match is small.

2.4. Three-dimensional Panoramic Platform Loading Technology.

Before studying the panoramic image generation technology, it is necessary to theoretically understand the camera imaging geometric model and the resulting image conversion model. It is the basis for generating panoramic images. The conversion model between the captured images can be obtained by the camera imaging geometry. They are the mathematical foundation of image registration and image stitching. Before stitching the images, it is necessary to select an appropriate image transformation relationship model according to the geometric relationship of the camera imaging. Mastering the geometry of camera imaging is also the basic premise of image stitching.
Different camera movements will result in different imaging effects for the scene. The image transformation model describes the coordinate transformation relationship between two two-dimensional images.

When two or more cameras share the same viewpoint or shoot a plane scene, the acquired two-dimensional images can be associated through perspective transformation. The solution of each parameter of the perspective transformation matrix $H$ is the key content of various image registration algorithms. Transformation matrix estimation algorithms can be divided into four categories: algebraic methods, geometric methods, robust methods, and statistical methods. The algebraic method is linear, and it obtains the estimation result through matrix singular value decomposition. The principle is simple and easy to implement, but it is very sensitive to noise, unstable, and has poor estimation accuracy. The above method is only applicable when the measurement error of the measurement data is small, and is not applicable to the case where the measurement data contains abnormal values (wrong data points). Once there are outliers in the input data, even if the number of outliers is small, if the first two methods are used, the estimated results may be very different from the actual values. So commonly used robust methods, such as M estimation, minimum mean (LMEDS), random sample consensus (RANSAC). Among them, RANSAC is a reliable and widely used method to solve the perspective transformation matrix. Statistical methods estimate model parameters under a probabilistic framework, and their calculations are more complex and improved.

Through the processing of the above steps, the main process of 3D reconstruction has been completed. In order to achieve the visualization effect of the 3D platform scene, it is necessary to perform grid processing on these data. Based on the idea of multi-source data fusion, formulate a unified system structure, unified data exchange format, etc., put forward a set of standardized principles and requirements, meet the requirements of 3D animation rendering and browsing requirements, realize the mixed call of multiple data, integrated application, Ensure 3D data consistency, reliability and effectiveness.

The three-dimensional visualization expresses the accurate representation of objects and features in space, and also meets the needs of later rendering and system integration, enriches the content and form of three-dimensional spatial data, and realizes data sharing and application.

3. Engineering Application
The three-dimensional visualization technology is widely used in urban planning, geological engineering, water conservancy and electric power survey and design, etc. It has important practical
significance for promoting modernization development. The application platform integrates a variety of data for sharing and utilization, and has important significance for improving the level of information management.

The platform realizes the loading and display of the three-dimensional platform by importing various types of data. The specific applications are as follows:

4. Conclusion

The three-dimensional platform system is based on a three-dimensional data management platform to compile and publish three-dimensional modeling data, image data, and terrain data, and publish and manage data services and various types of query analysis services. The platform supports complete services such as sharing, publishing, browsing, editing, analysis and retrieval of massive three-dimensional geographic information data. It provides a complete solution for three-dimensional geographic information services that supports "data-software-service-application" integration.

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6. References

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