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Study on the Seamless Integration Technology of Oblique Photography Real-time Model Base on AutoCAD

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Abstract. The application of oblique photography real-time model is more and more extensive in recent years. In order to meet the demand of putting oblique photogrammetry data in AutoCAD for displaying and editing in the land and planning departments, aimed at the characteristics of AutoCAD and oblique photography real-time model, this paper discusses the key integration technology of oblique photography real-time model and AutoCAD based on the secondary development technology of OSG and ARX, such as the oblique photography model data conversion and the fast dynamic LOD display of oblique photography real-time model based on the secondary development technology of OSG and ARX. The applied example shows that the method proposed in this paper is suitable for the analysis and display of the oblique photography real-time model directly in AutoCAD, and provides a certain reference value for the application of oblique photography reality model for the S/M units.

1. Introduction

With the development of surveying and mapping technology and proposal of the concept of smart city, the oblique photography 3D real-time modeling technology has broken the traditional 3D model making and real scene restoration because of its efficiency and rapid[1], which can provide people with more complete, more realistic and high-precision basic 3D spatial information data of smart city construction to assist urban planning, construction, management and analysis[2]. Its application prospects are getting wider and wider. At present, there has been some research on the visualization and process of the oblique photography real-time model[3-5] at home and abroad. The market has also introduced oblique photography data processing software system, such as the ASTRIUM's Street Factory and the Smart 3D Capture of Acute3D in France, the Pictometry's Pictometry system in the United States, the SkylineGlobe's the Skyline and SuperMap GIS 7C (2015) version of SuperMap[6-7] in China. However, a problem is that these software systems are just only the independent third-party software. And so far, the seamless integration technology of oblique photography real-time model is only based on the research of the above-mentioned oblique photography processing software[8-13]. There are no related studies based on AutoCAD. The oblique photography real-time model can't be integrated into AutoCAD, which will greatly limit the application of the oblique photography real-life model in departments such as land and planning.

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Therefore, this paper proposes several key seamless integration technologies of oblique photography real-time model based on AutoCAD. Firstly, based on the C++, the OpenSceneGraph (OSG) and the ObjectARX (ARX) technology are used to convert the oblique photography real-time model into DWG model which is loaded by AutoCAD. Secondly, based on the Level of Detail (LOD) technology, the organization of oblique photography tile data is analysed, then these tile data are filtered and utilized dynamically by obtaining the line of sight of 3D view, and at last the dynamic LOD display of oblique photography real-time model is realized and the speed of data loading and rendering in AutoCAD is accelerated. Finally, based on the above technology and the thinking of object-oriented, software engineering and plug-in technology, the system function and AutoCAD are successfully integrated seamlessly. Those methods and techniques proposed in the paper provide a reference for the surveying and mapping production unit to apply the oblique photography real-world model.

2. Key technology

2.1Analysis and storage of oblique photographic data

Most of the domestic oblique photography real-time data is stored in the OSGB format[14], but the OSGB format data cannot be directly loaded in the AutoCAD, so the OSGB data needs to be parsed into an AutoCAD loadable data format. Because in the market the model information and texture information are stored as the same OSGB file in most instances, that is, model information and texture information are embedded in the OSGB model data, the model information and texture information need to be extracted from the OSGB data.

To solve this problem, first OSG is used to store the model information and texture information in the OSGB data separately as model data and texture data files which is stored by means of JPG images. Then the model data which includes data such as vertex data, texture coordinates, and surface vertex index is reorganized. These data can be reorganized into DWG model data base on the organization of DWG and finally the analysis of oblique photography data was completed. This technical route of oblique photography data parse as show in Figure 1.

Li, C. K. and other scholars[15-16] pointed out that, there are two common methods of establishing LOD—static LOD and dynamic LOD. Dynamic LOD is a method of generating any number of consecutive, adjacent LOD by the algorithm of model simplification. Although this method can maintain good visual smoothing effect during switching the model, certain data will be lost during the simplification process. And because this algorithm is computationally intensive and complex, the speed of the system will be affected. Compared with dynamic LOD, in case of the current sufficient storage space, static LOD[17] can pre-generate several levels of detail models before rendering, and then determine the required resolution and level of detail according to the algorithm during rendering. Because it is not necessary to implement the model level construction by algorithm, the drawing speed is increased. Therefore, after the model information and the texture information are parsed from the OSGB data, the model data is cached in the system's working directory in advance, so that the subsequent real-time model can be used for displaying and rendering in AutoCAD.

2.2The displaying and rendering of large oblique photography real-time model in AutoCAD

The oblique photography real-time model is obtained by oblique photography technology. It is a geometric mesh model with high realism, rich shape, high spatial position accuracy and large data volume[18]. Overall tile file of oblique photography real-time model are tens of GB or even hundreds of GB. AutoCAD as a non-real-time rendering platform, takes a lot of time for such a large amount of texture mapping, especially when the number of the vertex is large, the delay is rendering seriously. According to the characteristics of the OSGB data with pyramid level, the LOD is constructed and the static data is called hierarchically by the change of the viewpoint to reduce the system memory consumption and speed up the data loading and display. In addition, to display the oblique photography real-world model in AutoCAD, it is also necessary to comprehensively consider the rules

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of 3D display in AutoCAD and the mechanism of its 3D model construction. this technical route is shown in Figure 2.

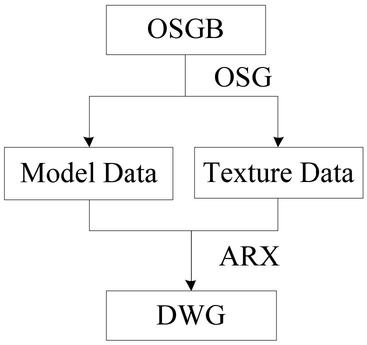


Figure 1. The technical route of oblique photography data parse.

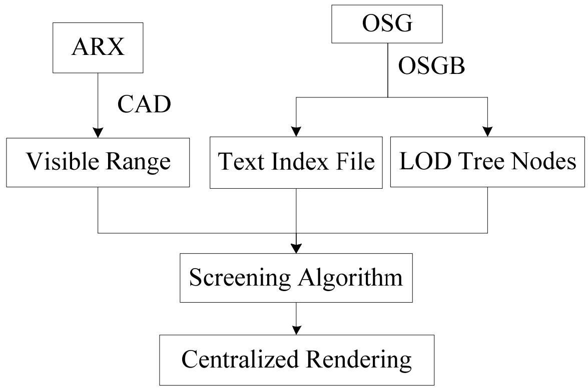


Figure 2. The technology route for the display and rendering of large-scale oblique photography real-time model in AutoCAD.

2.2.1Build the text index of static data

The converted data is a plurality of single static data. To load all the data in AutoCAD, the text index must be constructed according to the LOD structure of the original data. first the bounding box of each DWG file is obtained separately, and then the information such as the path of the file and the bounding box coordinates is written into the text index. At the same time, the top-level of DWG file is filtered and then their bounding box is merged to form the minimum bounding box of the index's construction. Finally, its bounding box's coordinates are written into the text index to complete the text index's construction of the static data.

2.2.2Dynamic display of real-time model based on the change of line of sight

The correct distance in AutoCAD corresponds to the hierarchical relationship in the LOD and the loading of the data block, which will determine the visual experience of the entire system. The fineness of the real-time model scene decreases as the distance from the viewpoint to the model increases. When the distance from the viewpoint is far away, some details become unimportant, you can choose a lower resolution, or even choose not to display. A change in the size of the zoom distance causes a change in the camera's focal length and visual range. The basic principle is that the farther the camera focal length is, the lower the displayed LOD level and the larger the visible range, the more data blocks are displayed. The focal length of the camera can be obtained by obtaining the projection length of the screen length or width in the real model plane. Whether the camera focal length change is determined by the screen length or the width can be determined according to the bounding box of the entire model. The visible range is a sphere. Its centre is the projection point of the centre of the screen in the WCS (World Coordinate System), and its diameter is the projection length of the length of the screen in the WCS.

2.2.3The organization mode of LOD tree nodes

It is to use tree-like node organization to organize oblique photography data. This organization is shown in Figure 3. The structure of this organization is like a tree. From top to bottom, it is root, LOD, group, and node. Multiple LOD nodes form a root node, which store a list of visualization ranges for each node, and are responsible for hierarchical display tasks. The group mainly saves the list of child nodes. The node mainly saves its name, level and grid number, and the grid number of the parent node. All nodes will decide whether to render based on their own outer envelope borders. When the system displays data, an access node of the LOD tree is constructed and traversed. Then all the nodes are filtered according to the current camera focal length and visual range to determine which nodes need to be displayed. Render the nodes that need to be displayed, the model data is copied to the current

AutoCAD model space for display according to the cache file (DWG file) path of the rendered node and the nodes that need to be hidden at the same time is deleted.

3. Application example

3.1System general design

In order to verify the effectiveness of the key technology in this paper, the AutoCAD 2017 is used as a system development platform, and in the Visual Studio 2015 development environment, the C++ is used to call the OpenSceneGraph (3.6.1) and the ARX (2017)'s library. Finally, a system is designed by using the layered structure. This architecture of an integrated system is shown in Figure 4.

The first layer is the data layer, which is the OSGB source data. This source data is collected by the drone and have been a certain processed. The second layer is the basic development layer, including the OSG parsing module and the LOD algorithm and the ARX rendering module. The OSG parsing module is the module that parsing the OSGB data by using OSG to reorganizes the model data and texture data therein, and then these two types of data are stored in the form of files. The LOD algorithm and the ARX rendering module is the module that using ARX to realize the display of the 3D model in AutoCAD. At the same time, using the LOD algorithm to dynamically load the OSGB data according to the change of the viewport coordinates and orientation in the AutoCAD's graphics window, and combine ARX to complete the rendering of the OSGB data in the window. The third layer is the application layer, which completes the import, export, display and rendering function of the oblique photography data real-time model on the basis of the first two layers.

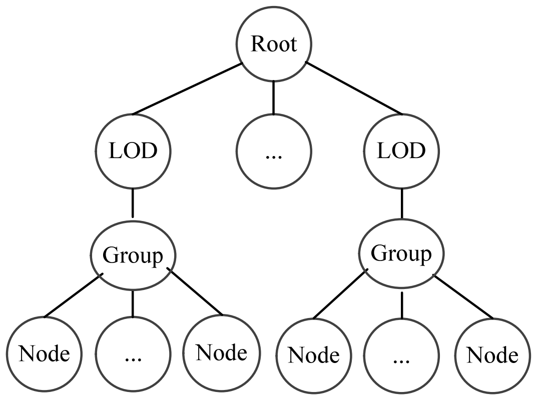


Figure 3. The organization mode of the LOD tree nodes.

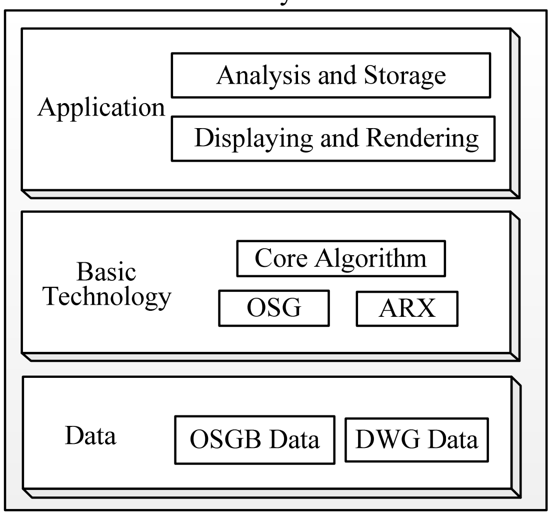
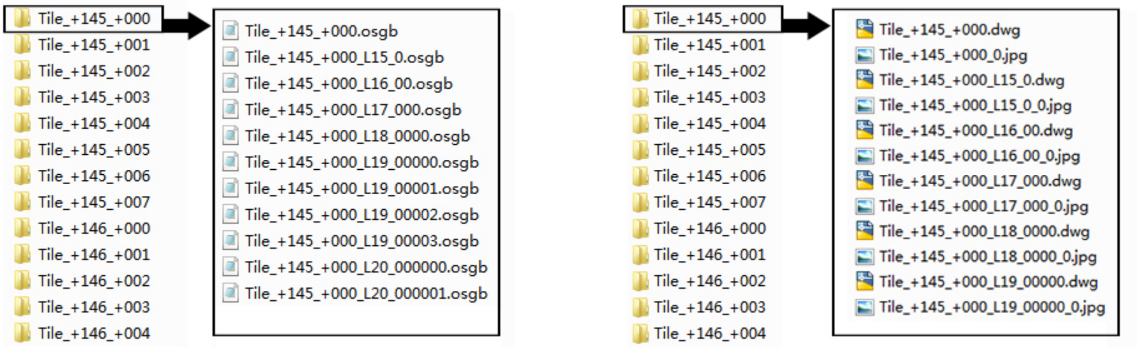


Figure 4. The architecture of the integrated system for oblique photography real-time model processing base on AutoCAD.

The source data selected in this paper is the OSGB data which is collected by the drone in Hangyang, Nanning city, China, and have been a certain processed. This data has a total of 71 tile blocks, a total of 10 levels (L14-L23), and a total of 3.12 GB of memory.

3.2System function implementation

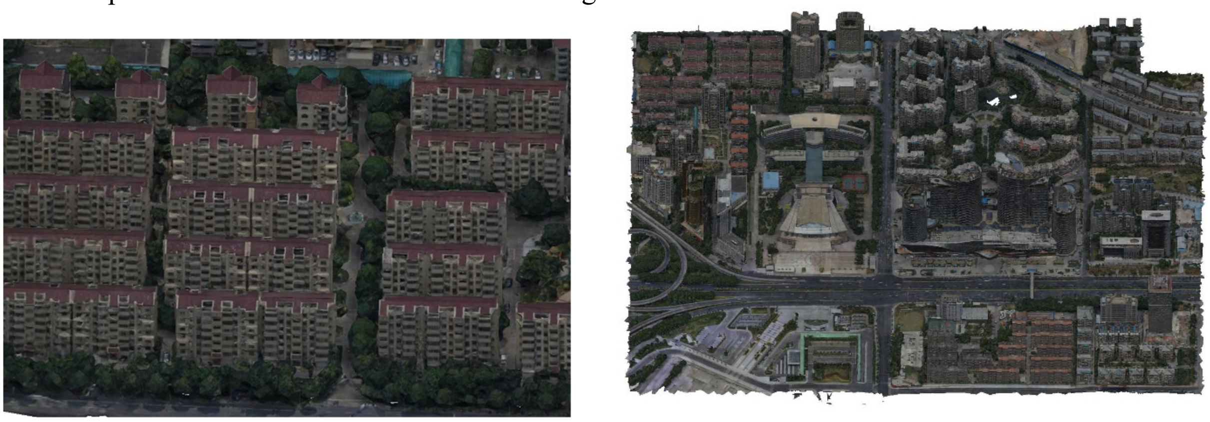
The system is mainly composed of the oblique photography real-time model parse module and the oblique photography real-time display module. The oblique photography real-time model parse module mainly uses the OSG to realize the file reading and parsing of the oblique image data of the OSGB (including 3D spatial data and pixel data parse). These parsed data are organized according to the original OSGB file and stored on the computer disk and create a new index file. This organization structure of the OSGB file set and DWG file set as shown in Figure 5.



(a) **(b)**

Figure 5. Illustration of (a) is the original organization of OSGB data set before conversion and (b) is the organization mode of DWG data after conversion.

According to the design method of this paper, the oblique photography real-time model display module mainly organizes the data obtained by the oblique photography real-time model parse module according to the tree structure, realizes the data LOD display and rendering. When the model is browsed, the model display of the current perspective is also updated in real time. It provides a smooth visual experience. The final result is shown in Figure 6.



(a) **(b)**

Figure 6. Illustration of (a) is the partial display of oblique photography real-time model in AutoCAD (current display level is 19) and (b) is the panoramic display of oblique photography real-time model in AutoCAD (current display level is 15).

3.3Problem analysis and prospect

- The memory occupied by oblique photographic data increases after conversion.

From the perspective of a single model file, the OSGB model file containing the same model information is much smaller than the DWG file. This is related to the way the files are organized in different formats. Under the premise that the organization of the document cannot be changed, it is necessary to consider the appropriate amount of OSGB model simplification in the process of parsing OSGB data.

- There are a large number of model triangles, and 3D data visualization loading in AutoCAD still needs to be strengthened.

Since AutoCAD is not a real-time rendering system, it is not possible to merge rendering operations. Therefore, although the system has already loaded the display using the LOD method, it is still difficult to speed up the display speed of the system. It is need to combine the computer technology to optimize the design of the system.

4. Conclusion

This paper mainly discusses the key integration technology of oblique photography real-time model and AutoCAD, include the analysis and storage of oblique photographic data, displaying and rendering of large oblique photography real-time model in AutoCAD. On the basis of these technologies, it was considered that the realization of an integrated system of oblique photography real-time model processing based on AutoCAD proves that these technologies can solve the practical problems in the national land department, such as the current convert oblique photographic model and quickly loading and displaying this model in AutoCAD and so on. It provides a technical basis for the fusion of multi-source 3D model and loading of 3D models in a variety of professional design software into oblique photographic data processing systems.

However, there are still many problems in the technology mentioned in this paper. The problem of that the memory occupied by oblique photographic data increases after conversion needs to be considered and the speed of loading a large amount of oblique photographic data in AutoCAD still needs to be improved. In order to make up for this deficiency, in the future, it is possible to study the related methods of simplifying the model data in the process of converting the oblique photography model. In addition, in order to expand the application of the real-time 3D mapping system in various professional fields, it is necessary to further study the related technologies such that the surveying and mapping personnel can directly edit the oblique photography model in AutoCAD.

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