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Three-dimensional Visual System of Airport Site Selection based on SuperMap

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Abstract. Traditional airport location work mainly relies on 2D CAD drawing to draw and express the intersection relationship of multiple three-dimensional planes in space. In this way, the mapping speed and update are slow. And it involves more professional knowledge. It is difficult for non site professionals such as the planning department and the government to understand. They still use the method of manual on-site measurement points to calculate the excavation and filling volume, which makes the site selection work and earthwork volume calculation in the site selection stage time-consuming and laborious. In this paper, the airport model based on CAD design drawing and the three-dimensional real scene model of the site to be selected based on photogrammetry technology are established. The two-dimensional GIS analysis function and three-dimensional GIS visualization function of SuperMap are used to realize the high integration of two-dimensional data and three-dimensional GIS, and the three-dimensional real scene model of airport with superimposed design drawings is established, which is used for the evaluation and display of airport site selection.

1. Introduction

At present, China's airport site selection has formed a set of mature working methods and theoretical systems. However, in the face of the current complex construction environment, relying on the traditional location method can not effectively analyze the constraints among the influencing factors. For example, there is no collaborative and visual analysis on runway orientation, proposed elevation, obstacle evaluation, the relationship between airport design map and original terrain, and the working mode of independent analysis of each part can only ensure that each part is optimal, but cannot guarantee the global optimization. At the same time, the existing airport location planning scheme still relies on small-scale topographic map and CAD tools, which lack of application of GIS, UAV aerial modeling and other visualization and high-precision tools. Although the two-dimensional planning system played a very important role in the early planning work, it can not adapt to the new situation of development and change, the demand of spatial analysis and decision-making is difficult to be met, and the three-dimensional display ability is poor. This leads to low efficiency and low precision, and it is difficult to compare the sites to be selected[1].

In this context, considering the main factors affecting the airport site selection, using the modeling idea of system engineering and photogrammetry technology, the three-dimensional model of the site to be selected is established, and the model and design data can be visualized and embedded by SuperMap, so as to effectively integrate multiple factors of airport site selection, improve the location efficiency, improve the accuracy of location cost calculation, and promote the airport location method Scientific[2].



2. three-dimensional scene construction based on SuperMap

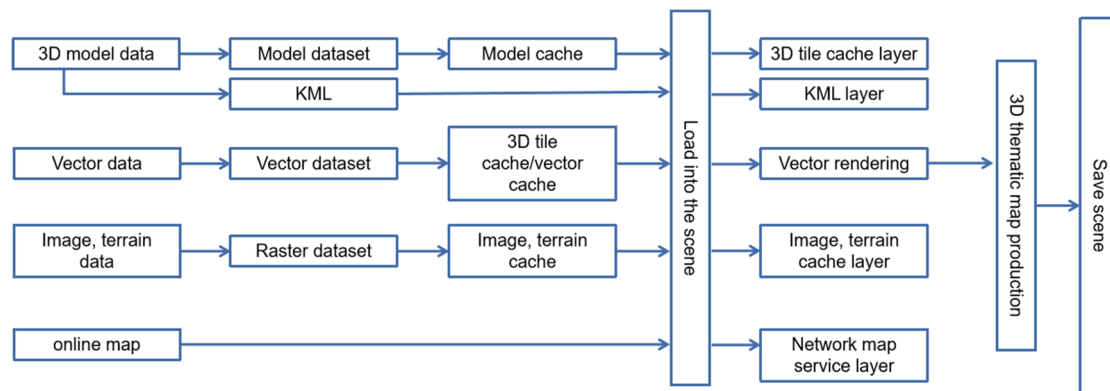


Figure 1. Flow chart of three-dimensional scene construction

According to the real geographical environment, the three-dimensional visualization system of airport location based on SuperMap will import the basic geographic information data, thematic data, three-dimensional models, runway design drawings, etc. into the system[3]. The site selection related personnel can browse the three-dimensional scene in an all-round way, and can fly, survey and three-dimensional perspective in the scene through mouse and keyboard.

3. Task steps

3.1. UAV data acquisition

When UAV field data acquisition, first get the regional scope sketch map (it can be KML, KMZ or DWG format file), import the survey area range into Google Earth, and understand the survey area area, regional terrain, regional average altitude, regional elevation difference and other information. Then, the image control points are pre arranged in large area of Google Earth. The image control points can control the relative position of the ground through the calculation method of spatial triangulation. After pre layout of image control points, select appropriate materials to lay image control points on site. Then, choose an open and flat location for the aircraft as a safe take-off and landing site.

3.2. Interior modeling

In the process of in-house data processing, the UAV measured data, processed POS data and RTK measured image control point coordinates are imported into the modeling software. Bentley's context capture is selected as the modeling software for this interior processing[4][5]. Its working principle is to analyze several photos of static objects taken from different viewpoints, and automatically detect the pixels corresponding to the same physical points, and infer the relative orientation of the photos and the three-dimensional situation of the scene[6].

In order to provide three-dimensional analysis application, three-dimensional scene needs DSM digital surface model, which can be processed by pix4d software, and DSM model with different range and precision requirements can be generated according to the needs .

4. System function realization

4.1. Visual display of relationship between proposed runway and terrain

Through the two-dimensional and three-dimensional integration function of SuperMap, the three-dimensional model of mountain scene and runway design drawing are strictly matched by coordinates, and the relationship between them is reflected. Through the three-dimensional visualization system of

airport site selection, it can be seen that most of the mountains exceed the runway elevation, and the relationship between terrain and design data is clear.

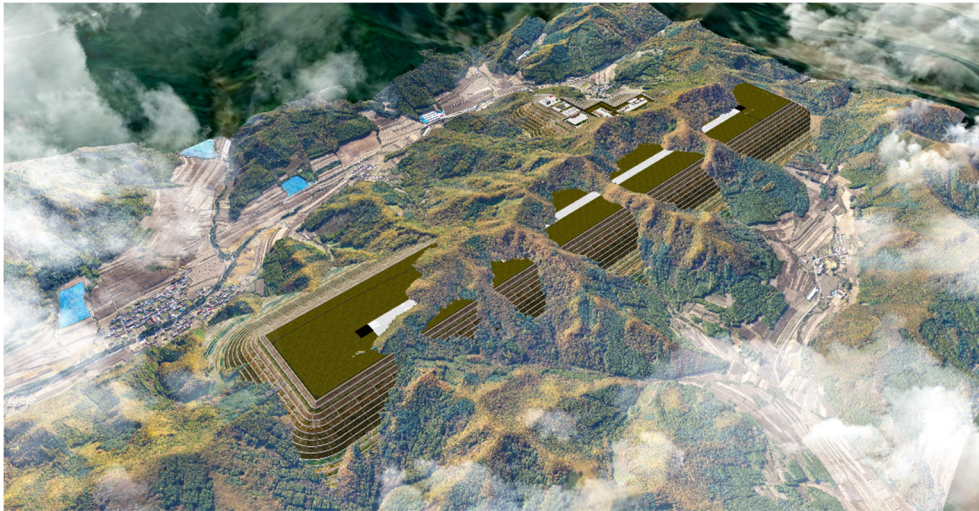


Figure 2. Visualization of relationship between proposed runway and terrain

4.2. Visualization of excavation area

The system provides measurement, attribute query, visual field analysis, land red line analysis and other functions for site selection. The excavation area shows the height control area within the safe range of the runway. According to the specified height limit value, it can automatically detect whether there are still buildings, mountains and trees beyond the height control requirements in the area. In this way, site selection staff can view and judge whether the height of surrounding buildings and mountains is reasonable, which is helpful to improve the planning scheme.

4.3. Calculation of excavation and filling volume

Generally, the calculation of excavation and filling volume is based on the calculation of the upper and lower bottom area of Earthwork by using the volume formula of prism.

$$V=1/6 \times H \times (S_{\text{Top}} + 4 \times S_{\text{Middle}} + S_{\text{Bottom}}) \quad (1)$$

Calculate earthwork volume by formula (1). S_{Top} is the top surface area, S_{Middle} is the middle section area, S_{Bottom} is the bottom surface area

S_{Bottom} is the area of the sum of the building area of the ground floor and the outer wall skin to the bottom line of the excavation (including working face, drainage ditch, grading, etc.). S_{Top} and S_{Middle} are calculated in the same way.

In the SuperMap platform, the topographic map after the embedded runway can be compared with the topographic map without the runway mosaic, and the excavation and filling volume of this scheme can be directly obtained. The results of excavation and filling volume of different schemes can be compared by changing runway azimuth and elevation. However, the terrain data uses the surface elevation model DSM, which includes the height of surface buildings, bridges and trees, and the earthwork volume calculated from this will have some deviation, so the model data still needs to be processed in the future.

4.4. Slope ratio display

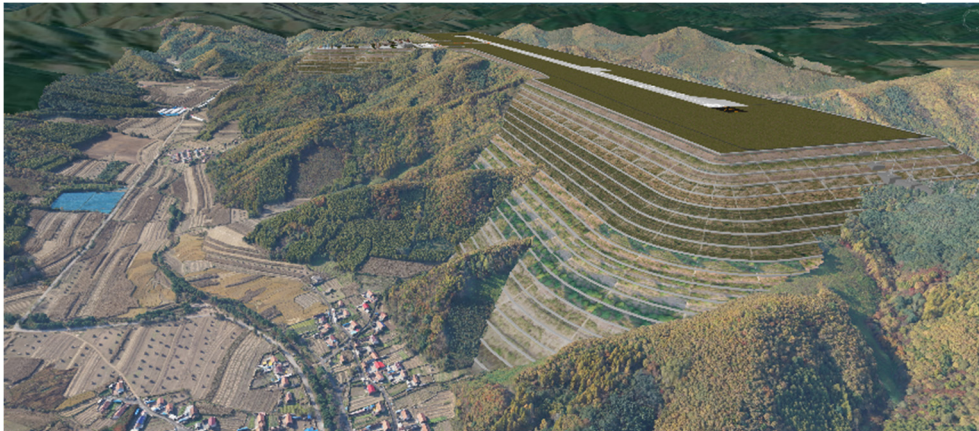


Figure 3. Visualization of slope ratio of proposed runway

4.5. Visualization of overlay topographic map on runway design map

Through three-dimensional visualization, the system enhances the representation form of site selection and improves the performance effect. Through comparison and selection of multiple schemes and comparison of scheme indexes, the site to be selected is observed and considered from multiple angles and aspects. Different schemes are compared by switching the same view. When the scheme is reported, the design parameters, planning information, demolition cost and other information of each scheme can be queried in real time. It can help the non site selection professionals to quickly understand the situation of each site, reduce the number of manual reconnaissance, save time and manpower. At the same time, it can observe the site to be selected globally and provide auxiliary support for manual visual site selection.

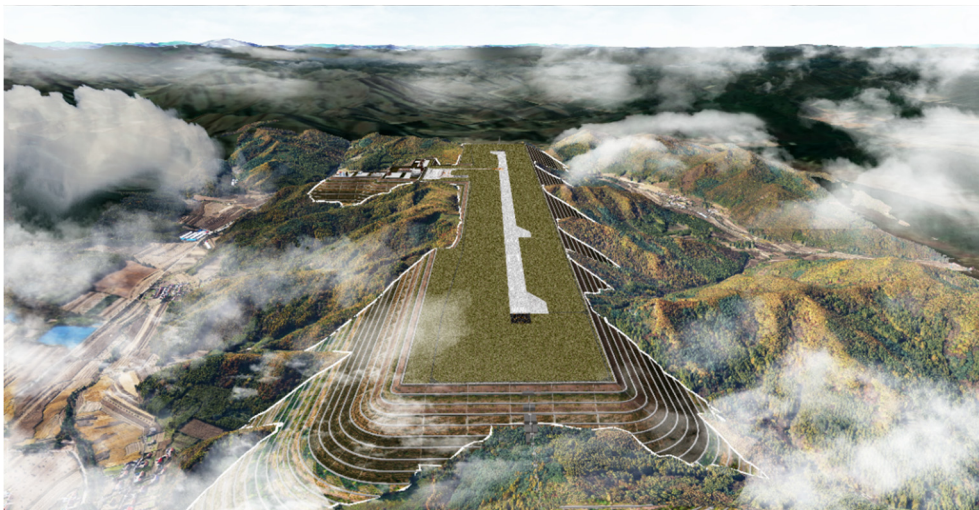


Figure 4. Visualization of overlay topographic map on runway design map

5. Conclusion and suggestion

This paper mainly uses photogrammetry technology to obtain the high-precision three-dimensional model of the airport site to be selected. The model and design data are imported into SuperMap platform to realize the three-dimensional visualization of airport site selection. The runway orientation, excavation and filling volume, demolition cost and other aspects of each site to be selected are

compared and displayed in the geographic information system, and the runway orientation can be changed for continuous optimization, comparison and optimization. The results show that the airport location visualization system based on SuperMap platform is feasible and practical. It can effectively improve the efficiency of airport site selection, and solve the complex problems of multiple factors, large dimensions and strong correlation. At the same time, the traditional two-dimensional data to three-dimensional effect display, often need to switch back and forth in multiple software, design drawing, model conversion each other, spend a lot of manpower, but based on SuperMap 10I platform can quickly realize multi angle and full dimension display of results editing and modification. Second, three-dimensional linkage technology can process the results in real time and dynamically, which greatly improves the work efficiency and provides important technical support for site selection.

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