The Application of Realistic 3D in Passenger Cableway Route Selection and Planning

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Abstract. Passenger ropeway line selection is often constrained by topography, architecture, protection of trees, geology and other factors, and the traditional passenger ropeway line selection to the two-dimensional map selection as the main way, supplemented by on-site surveys. This way of working often can not be integrated to grasp the various constraints on the line selection area, line selection efficiency is difficult to improve, and can not intuitively show the real natural landscape on the line, trees, terrain obstruction, etc., the line selection work is often repeated, the effect of line selection is difficult to ensure.Therefore, this paper explores the design of mountainous landforms real 3D data acquisition, real 3D application of passenger ropeway route selection process and other technical methods to real 3D data as a base, its innovative application in the passenger ropeway route selection work, combined with the ecological protection of the red line, the distribution of cultural relics, topography and geomorphology of the data, in the real geographic environment to carry out the work of 3D route selection. Based on the developed 3D visualization system of the ropeway, reasonable planning of ropeway routing is carried out through the functions of station and bracket drop zones, line display, fill and excavation analysis, passability analysis, profile analysis and so on. Through practice, it has been proved that the use of realistic 3D technology can effectively improve the passenger ropeway line selection line selection program, improve the efficiency of line selection, reduce the line selection repetitively, and improve the scientific nature of the decision-making of line selection program.

Keywords: Passenger ropeway; Intelligent scenic area; Realistic 3D; Spatial analysis

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1 Introduction

With the progress of science and technology and the arrival of the digital era, the realistic 3D technology has become a cutting-edge technology direction that has attracted much attention in the field of geographic information, which use advanced UAV tilt photography and LiDAR and other equipment to quickly obtain high-precision 3D data of the target area, providing intuitive, real, 3D geographic information support[1]. Realistic 3D can reflect the real features to a great extent, and is widely used in industries or scenes such as smart city [2], geology[3], water resources exploration[4], and cultural relics protection[5], which can effectively improve the efficiency and informatisation of related industries. At the same time, the real 3D can provide more intuitive and real 3D work base map for the cableway routing work. For areas with large undulations, the method of imitation ground flight is used to carry out UAV inclined photogrammetry, which can obtain high-quality realistic 3D data.

Passenger ropeways, as an important modern means of transport, are able to adapt to different topographic and climatic conditions with their high efficiency, environmental protection, small footprint, and high visual experience, and play an important role in mountain-type scenic spots, ski slopes and other complex terrain scenarios[6-7], as well as bring considerable economic income. Ropeway routing is an important work and key link in the pre-construction of ropeway, which is directly related to the ropeway's construction difficulty, operational safety, economic benefits and operational efficiency[8], and the reasonable route direction can effectively reduce the ropeway operational risks and safety hazards, and at the same time, it can also enhance the overall competitiveness of the scenic area. The traditional ropeway route selection method mainly relies on two-dimensional drawings and manual survey, there are problems such as incomplete information acquisition, low precision, low efficiency, etc., and it’s difficult to ensure the scientificity and accuracy of route selection. With the gradual development of realistic 3D, it has been applied in the fields of transmission line routing[9], railway routing[10], road routing[11], which broadens the technical path of line optimisation and results presentation.

Based on the realistic 3D, construct the 3D analysis system, apply the realistic 3D to the passenger ropeway route selection work, mainly including the scenic area realistic 3D data acquisition and production, the realistic 3D applied to the passenger ropeway route selection design, the passenger ropeway route selection. The aim is to reduce the field work, improve the efficiency of line selection, reduce production costs and so on. However, the current domestic and international research on the application of realistic 3D to passenger ropeway route selection is relatively small, and there is an urgent need to explore the data acquisition, route selection process, and the required functions of the system.

Therefore, this study aims to explore the application of real-view 3D technology in passenger ropeway routing, to solve the gaps in the application of real-view 3D technology in passenger ropeway routing, to improve the accuracy and efficiency of passenger ropeway routing, to provide a scientific basis for ropeway planning and construction, and at the same time, to provide a theoretical basis and practical guidance for the popularisation of the application of real-view 3D technology in the fields of ropeway routing, intelligent scenic spots, and so on.

2 Research Methods

In order to deeply explore the application of realistic 3D in passenger ropeway routing, this paper adopts a variety of research methods and techniques, and the rationale for choosing these methods and materials is fully considered.

Firstly, the realistic 3D model is selected as the core base map data. The realistic 3D model can accurately present the actual conditions of topography, vegetation distribution and buildings along the ropeway, providing intuitive and detailed data support for route selection. Compared with the traditional two-dimensional map, the 3D model is more capable of reflecting the complexity and details of the terrain, which can provide more intuitive and comprehensive information support for the cableway route selection. Secondly, the UAV inclined photogrammetry is used to generate DOM data, carry out field research, combine with existing topographic maps or redraw topographic maps, obtain topographic and geomorphological data, and use geological survey to obtain the geological conditions of the route selection area.

In addition, based on GIS technology for the construction of the cableway routing system, the research and development of through-view analysis, fill and excavation analysis, attribute modification, etc. GIS can achieve the integration of spatial data, storage, editing, analysis and visualisation and other functions.

Design and optimisation of route selection scheme. Combined with the GIS analysis results, design a variety of cableway routing scheme. Using the visualisation function of the realistic 3D model, the route selection scheme is displayed and compared intuitively. Based on cost, safety, efficiency and other factors, optimise and adjust the route selection scheme and select the best one.

The realistic 3D data, DOM data, and laser point cloud data obtained by UAV inclined photogrammetry, together with geological conditions, scenic area planning and other information as the basis, provide more accurate, comprehensive and efficient data support for the research of realistic 3D technology in ropeway passenger routing, and GIS technology provides more scientific analysis support.

3 Technical Route

3.1 Realistic 3D Acquisition

In this study, the live 3D model generated by UAV inclined photogrammetry is used as the working base map for ropeway routing. Compared with the traditional means of measurement, inclined photogrammetry is able to obtain the texture characteristics of the same feature through multiple viewpoints, has the technical advantages of fast acquisition speed, low production cost, high model accuracy, and makes up for the shortcomings of traditional aerial surveys that can only be vertically photographed, and has a wide range of applications in the fields of digital city modelling and engineering surveying. It has a wide range of application prospects in the fields of digital city modelling and engineering surveying. Inclined photogrammetry often adopts the mode of fixed altitude for flight, which is more often used in cities, plains and other areas, while passenger ropeways are often installed in mountainous scenic spots, ski resorts and other areas with obvious height differences, some of which are as high as a few hundred metres, and the use of fixed altitude of inclined photogrammetry is often geometrically distorted, inconsistent resolution and other situations, so it's often used to imitate the ground flight technology to collect inclined photographic images, reduce the number of flights, and reduce the number of flights. Therefore, the technique of imitating ground flight is often used to collect inclined photographic images to reduce the data quality problems caused by height difference changes, and the specific flow chart is shown in Figure 1.

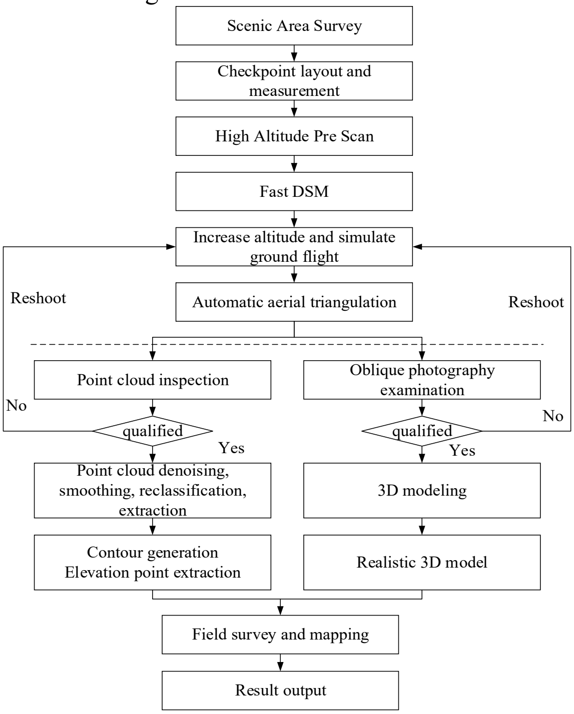

Fig. 1. Data construction process diagram.

First of all, conduct a field survey of the selected area, evenly select the location of the checkpoints and collect the location information, then apply for airspace, pre-sweep the selected area with a large aerial height, and observe the presence of trees, high-voltage pylons and other special conditions, and use a laptop computer to quickly generate a low-precision digital surface model, which is used as the basis for the laying of routes and the imitation of ground flights by UAVs.

The UAV generates laser point cloud data and tilt photogrammetry data by carrying different lenses, and processes the data separately. For the laser point cloud data, the data quality check is carried out, and the qualified data are subjected to point cloud denoising, smoothing, classification, extraction and other operations to extract the contour points and generate the contour data, which are used as the basic data for the line selection work and the supplement of the real 3D data. For the inclined photogrammetric image data, after checking the qualified data, the real 3D modelling is carried out to generate the real 3D model. The accuracy of the laser point cloud data and the real 3D data is verified in the field, and the qualified products can be used for the alignment work.

3.2 Cableway Route Selection Process Based on Realistic 3D Data

For the traditional passenger ropeway route selection method, the first step is to determine the approximate ropeway construction area, carry out field survey, complete the area survey and generate 1:500 scale topographic map, carry out geological survey and generate geological survey report, based on the geological survey report and topographic map, as well as collected scenic views and scenic area data for the selection of passenger ropeway routes, and adjust the routes according to the field conditions and the actual needs of the ropeway construction unit, which will cause problems such as poor topographic map presentability, reflecting the surface conditions completely, resulting in repeated passenger ropeway route selection work. This method may cause problems such as poor topographic map presentability and incomplete reflection of the ground surface, which will lead to the repetition of the passenger ropeway route selection work.

The technical route adopted in this study is shown in Figure 2, firstly, collect the existing scenic planning data, ecological protection red line, land use status map, geological conditions, protection of cultural relics distribution maps and other information in the scenic area, and carry out data conversion or vectorisation to construct a vector database, which will assist in the systematic GIS analysis. At the same time, based on the UAV inclined photogrammetry and laser point cloud measurement carried out in the early stage, data such as DEM, DOM, DSM, topographic maps, and live 3D models of the scenic spots are generated. Eventually, the classification and organisation of data and visual expression are presented in the developed system to achieve the in-depth fusion of realistic 3D data and vector thematic data, constructing a 3D geographic scene of the passenger ropeway routing and forming the data basis of the ropeway routing.

Considering the conditions of the line selection factors in the scenic area, the scope of the line selection area is circled, and the 3D line selection work is carried out in the selectable line area with full consideration of the line scenic area construction coordination, landscape consistency and other factors. The fall of the bracket and station house of the line selection scheme, the 3D rendering of the line selection scheme, the deep integration of the line selection scheme with the real geographic scene, and the data adjustment of the position, height, pitch angle, etc., in order to achieve the gradual optimisation of the scheme. Combined with realistic visual experience, GIS analysis methods such as cable car passability analysis are utilised to reduce repetition in later work. In addition, in the process of line mapping, simulation and comparison, the uncertainties in the scheme need to be verified and corrected by combining the supplementary survey information from the field.

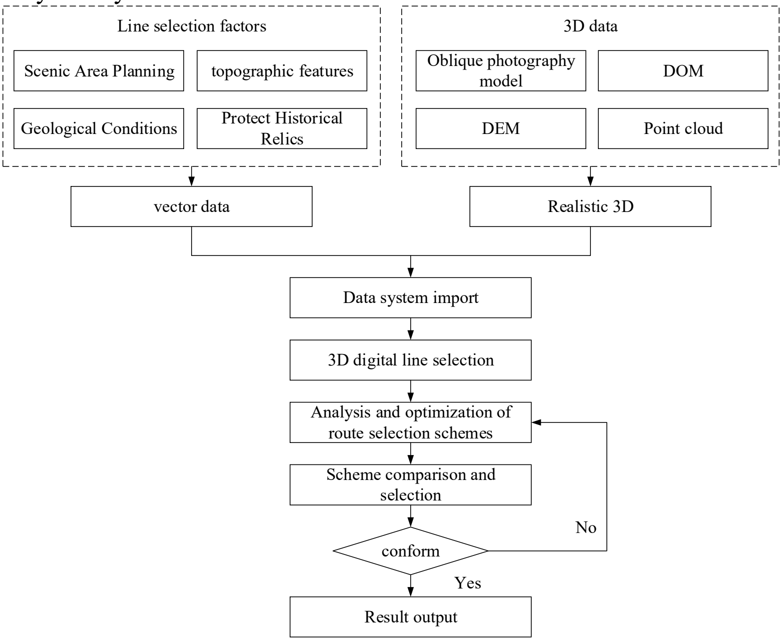

Fig. 2. Flow chart of wire selection

4 Practical Applications

4.1 Data Utilisation

The study area is a mountain-type scenic area, where UAV inclined photogrammetry and laser electric cloud UAV surveys are conducted to generate DEM, DOM, and DSM data products, as well as live 3D and laser point cloud data. The DEM generated by the inclined photogrammetry is used for slope analysis, which can grade the slope in the scenic area, and the scientific analysis of the bracket drop zones should be carried out reasonably for the areas with larger slopes, so as to ensure that the line as a whole tends to be gentle and to reduce the difficulty of the project. There is no topographic map data in the scenic spot, through the laser point cloud generated elevation point information and the real 3D data, combined with the field survey, in the mapping software for 1:500 topographic map production; in addition, the laser point cloud data is also used for the real 3D elevation data to supplement and assist in the verification. Collect the existing planning and design maps, geological survey reports, cultural relics protection, etc. in the scenic spot with the produced topographic map, integrate and unify the data format, and generate the geographic data base.

4.2 Passenger Cableway Route Selection

According to the scope constraints of the scenic area and previous passenger ropeway route selection design experience, combined with the rich data for 3D spatial analysis, in the 3D scene for the real presentation of route selection results. The specific path is to take the realistic 3D data and geospatial vector data as the base to construct its 3D geospatial scene, which provides accurate data support for route selection. Conduct 3D GIS analysis, such as buffer analysis and overlay analysis, for judging whether there are any protected cultural relics, whether forest land is occupied, and whether the ecological red line is covered, etc. in the area of line selection. Combined with the real 3D, DEM and other data for profile analysis as shown in Figure 3, to demonstrate the degree of gentle slope and terrain undulation curve of the selected line area, in order to judge the reasonableness of the bracket dropzon.

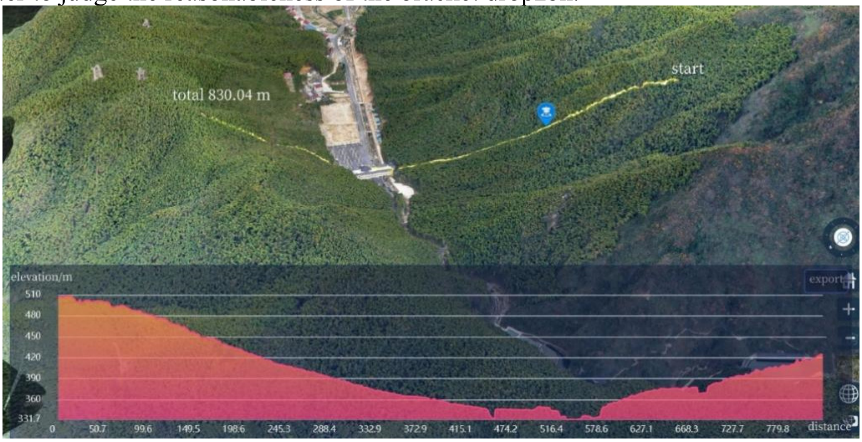

Fig. 3. Section Generation

After the analysis is completed, the fall of the pre-selected line is carried out as shown in Figure 4. For the station house, adjust the position, height and other attributes of the station house, generate the centre line between the upper and lower station houses, use the centre line as an aid to construct a custom coordinate system with the lower station house as the coordinate origin, and then drop the support model into the real 3D according to the relative position relationship with the lower station house and combined with the attributes such as pitch angle.

Fig. 4. Line selection and drop off situation

4.3 Optimisation of Passenger Ropeway Routes

Optimise and efficiently render the results of line selection in the system, and judge the harmony between the passenger ropeway and the surrounding landscape by combining with the 3D view of the real scene. Taking the following station house as the starting point, we carry out the view of the situation of the station house and the fall of the support, etc., and carry out key enquiries for the areas where the ropeway crosses with the walkway and the protection of cultural relics, etc. to judge whether there is any crossing. Combined with the realistic 3D and other data, the ropeway boom box passability analysis is carried out, and the area around the ropeway boom box of 7.5 metres each is drawn to check whether there is any collision with the mountain, trees and other obstructions. The passability analysis was carried out as shown in Figure 5. For the deficiencies in the scheme, online real-time adjustment of the support and station attribute data is provided as shown in Figure 6, and the optimisation and upgrading of the routing scheme is carried out in conjunction with the field view of the fieldwork and other work. At the same time, it's able to achieve the display of multiple ropeway routing, through the 3D display of the advantages and disadvantages between different ropeways, to provide decision makers with detailed data reference.

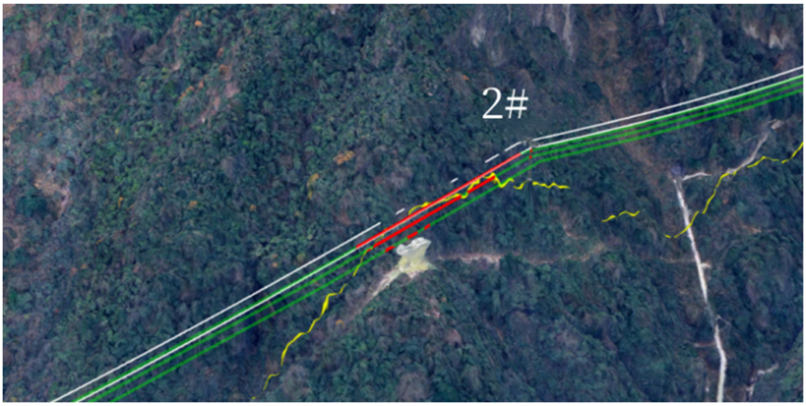

Fig. 5. Passing Analysis

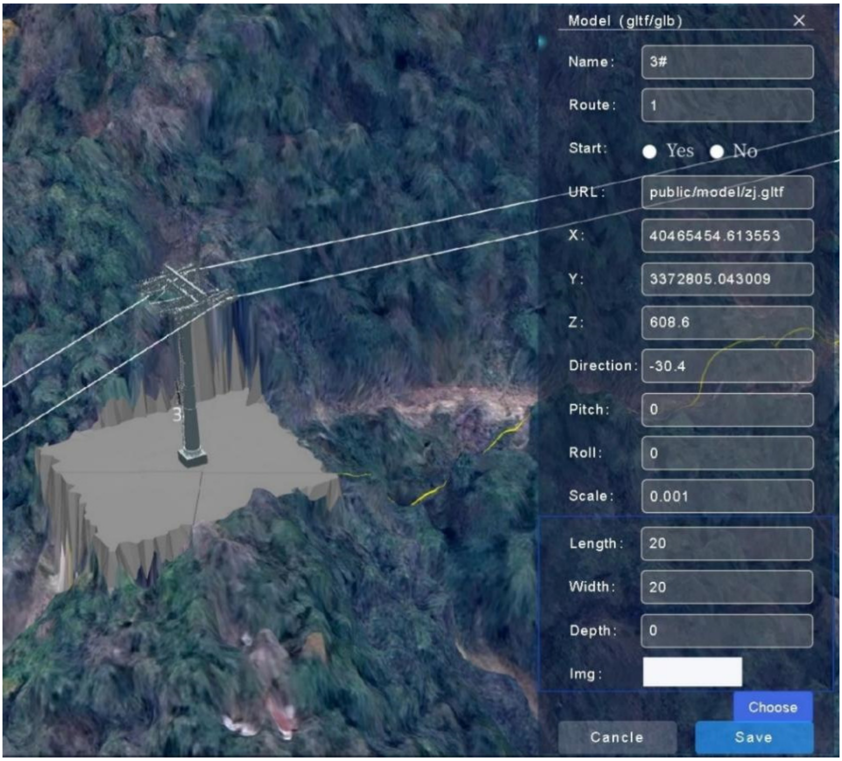

Fig. 6. Modification of bracket properties

5 Conclusions

This study explores the application of realistic 3D modelling in passenger ropeway routing by combining with practical projects. It has been proved by practice that the use of imitation ground flight technology can effectively solve the data quality problems caused by changes in elevation; the real 3D can restore the topography and landforms of the ropeway routing area, the distribution of buildings and other actual conditions, more intuitive than the traditional two-dimensional maps, more comprehensive and accurate, combined with topography, geology, planning and other data for the routing to provide a more detailed data base. Taking the real 3D map as the base map, the ropeway route selection system constructed on the basis of GIS technology will drop the station and the support, provide the reproduction of the scheme under the real geographic environment, realize the buffer analysis, superposition analysis, profile analysis, fill and excavation analysis and other analytical functions, assist in the scientific and reasonable work of passenger ropeway routing, and be able to find out the problems and hidden dangers of the plan in the early stage of the planning, so that it can be adjusted and optimized in time. In the optimisation stage of line selection, it uses through-view analysis to judge the passability of the boom box and provides the function of modifying the attributes of the support to achieve real-time optimisation of the line selection scheme, and quickly compares and evaluates different line selection schemes, which can greatly reduce the workload of the ropeway planning and selection, and the cycle of the ropeway planning.

Although the real-time 3D model provides rich information support, the determination of passenger ropeway route selection still needs to comprehensively consider a variety of factors, such as economic, social, cultural and so on, combining more big data and combining with artificial intelligence technology for the determination of route selection is the focus of the next research direction.

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