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数字校园室内外一体化三维模型制作

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摘要: 首先利用无人机测绘技术进行校园航拍, 并通过摄影测量内业处理软件制作校园正射影像图和数字线划图; 再利用测距仪精准量测建筑物室内结构和属性信息, 结合 SketchUp 三维建模软件绘制精准建筑物室内平面图, 并构建标志性室内外精细模型; 然后采用场景建模软件 CityEngine 进行校园批量模型生产; 最后集成 SketchUp 的标志性建筑物模型, 实现校园三维模型室内外一体化制作, 可提高学校对外宣传力度和促进校园信息化建设进程。

关键词: 无人机; CityEngine; SketchUp; 室内外一体化三维模型; 数字校园

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数字校园作为“数字中国”、“数字城市”的一部分, 虽然对应的空间范围较小, 但实现过程与上述二者有较大的共通之处, 可作为对“数字中国”、“数字城市”实现的一种初探。同时, 数字校园建设作为校园信息化建设的重要环节也有很大的现实作用, 对于学校宣传、管理以及师生生活具有一定的便利性。

目前国内高校的信息管理系统主要针对非空间信息, 很少涉及空间信息管理。部分学者或高校尝试从二维地图角度来管理校园, 但在可视化效果方面存在一定的不足。将不断推广的无人机技术、三维可视化技术应用于教育领域的三维校园宣传展示、校园动态规划建设等方面, 可为教育事业提供崭新的教育思维方式和手段。

无人机测绘技术具有效率高、成本低、数据精确、操作灵活等特点, 可满足测绘行业的不同需求, 正逐渐成为航空遥感数据获取的“标配”^[1]。首先通过无人机对目标区域进行航空摄影, 然后利用地面处理系统对数据进行处理, 最终制作目标区域的正射影像图、数字地形图以及 GIS 数字线划图等。SketchUp 软件灵活有效的绘图捕捉功能和数据输入功能提高了建模效率, 因此可利用该软件对室内进行精细建模。CityEngine 软件的优势在于可利用 CGA 规则, 快速实现三维模型批量建模; 同时支持 ArcGIS 和 SketchUp 数据, 并能完美集成, 可满足快速实现三维场景仿真建模的需求^[2]。

本文以扬州市职业大学为例, 利用无人机测绘技术进行校园遥感影像制作和矢量数据库创建, 并通过测距仪精准采集建筑物室内结构属性和图形信息; 再利用 CityEngine 和 SketchUp 两种三维模型软件构建数

字校园精细三维模型; 最后进行数字校园室内外一体化制作, 可有效提高学校对外宣传力度和促进校园信息化建设。

1 技术路线

三维建模需将模拟的对象和场景表达为存储在计算机内的三维图形对象集合, 包括二维平面图和三维模型构建。本文首先分别收集校内、外数据, 并结合内业软件进行数据处理; 再分别进行室内、外场景建模, 室内场景利用 SketchUp 软件绘制平面图, 并进行精细化建模, 室外场景利用 CityEngine 软件导入无人机测绘内业处理获得的空间数据库进行大规模批量建模; 最后将室内与室外模型进行一体化整合, 形成完整的数字校园三维模型, 还可根据需求进行浏览路径规划, 制作校园室内外浏览动画视频。整体技术路线如图 1 所示。

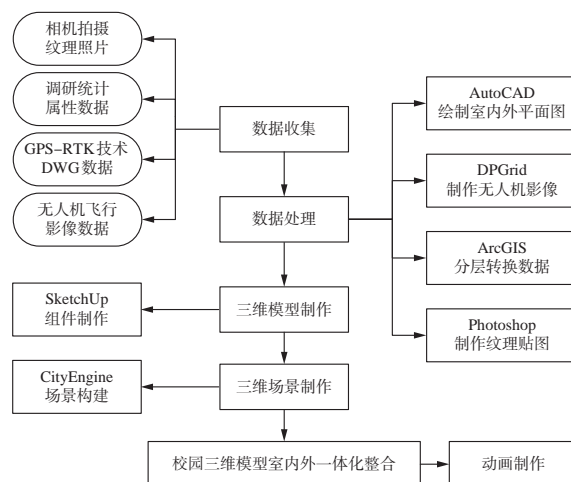


图 1 整体技术路线

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2 模型制作流程

2.1 数据收集与处理

1) 无人机外业航飞。本文选用国产大疆精灵 4 Pro 系列无人机, 快速获得研究区的多组像幅小、数量多、重叠度高的二维相片, 如图 2 所示。航飞前需检查仪器安装是否到位, 并确保遥控移动设备与飞控软件链接正常; 然后进行飞行区域航线规划, 原则上作业区域应大于最终所需区域。对于标志性建筑物(图书馆), 采用无人机围绕建筑物由上向下旋转拍摄的方式获得近距离建筑物影像的纹理相片, 如图 3 所示, 为后续室内外精细模型构建提供直观全方位的实体参考, 并可用作纹理贴图。

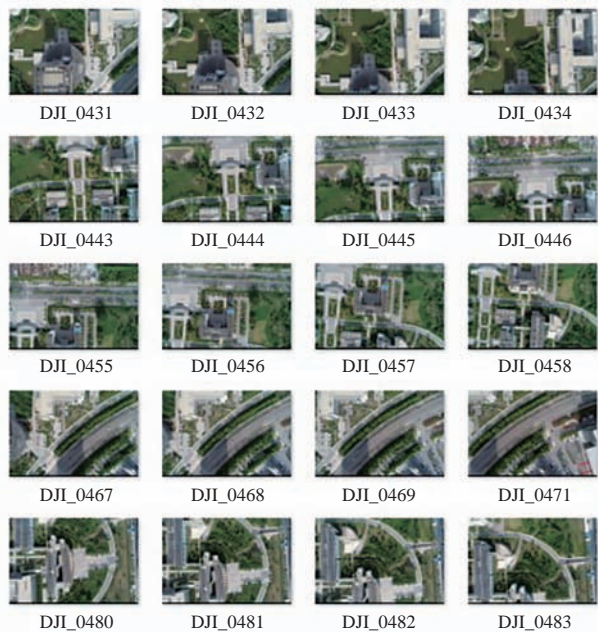


图 2 无人机航飞相片

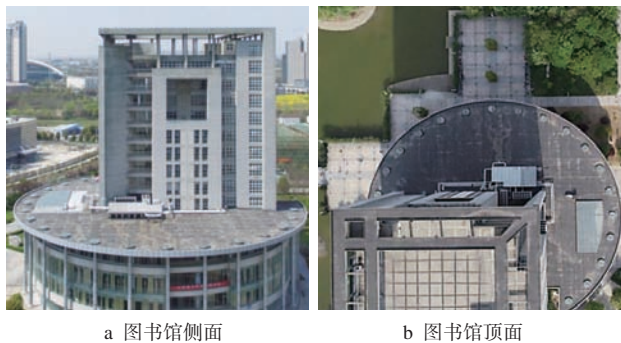


图 3 无人机近景拍摄

2) 摄影测量内业数据处理。首先, 对于校园室外各项专题图层, 本文采用操作简便、成图快捷的国产 DoubleGrid 摄影测量后处理软件对外业航飞成果进行 4D 产品制作^[3]。该软件可自动读取多组相邻相片的影像信息, 具有一键式快拼、带控制点空三制作与 4D 产品制作等功能, 可快速获得整体、高分辨率、大范围

的校园正射影像图(图 4)以及各项专题矢量数据, 如道路线、建筑物面、路灯点、植被面、河流面、体育设施面等。然后, 本文利用 ArcGIS 进行数据转换处理、拓扑分析、编辑整理入库^[4-5](图 5), 为后续数字校园建设提供基础底图。对于图书馆等标志性建筑物的室内设计, 本文结合 GPS-RTK 技术和测距仪, 对建筑物内部分层进行精确量测, 并利用 AutoCAD 详细准确地绘制室内平面结构图^[6-7]; 再导入 SketchUp 软件中精准绘制室内平面图, 并输入相关属性信息。



图 4 无人机正射影像图成果



图 5 ArcGIS 校园空间数据库

3) 纹理数据处理。对于无人机或高分辨相机拍摄的室内外纹理照片, 需利用 Photoshop 图像处理软件, 根据 GIS 空间数据库结构进行各类地物贴图处理。遵循图像清晰、尺寸规范等原则, 进行系统分类命名保存, 用于后期 SketchUp 建模贴图, 以增加模型的逼真效果和真实感。

2.2 模型创建

SketchUp 软件主要应用于城市规划设计、建筑方

案设计、园林景观设计、室内设计等领域,其在精致性、逼真性方面独树一帜,且能与 AutoCAD 和 GIS 等软件进行无缝集成^[8]。首先将处理好的校园二维平面分布图导入 SketchUp 工程项目,再根据三维模型构建原理,逐一对每个建筑物或特征地物进行三维设计与模型搭建,如标志性建筑物图书馆,除设计室外模型结构与样式外,还需结合室内每层结构,有序搭建建筑物空间结构(图6),贴合纹理图片,创建各组件的三维模型,从而实现室内外模型的有机结合(图7)。三维模型的精细度和逼真度决定了后续整个三维校园的质量,实施过程要求较高、耗时较长、效果较明显。

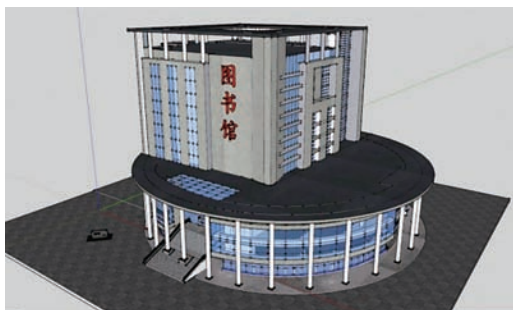


图6 SketchUp 建筑物结构模型



图7 SketchUp 室内组件模型

在 SketchUp 软件中完成校园建筑物或特征地物三维模型制作,并保存为 OBJ 模型后导入 CityEngine 软件中,通常会出现模型大小错误、外观纹理丢失等问题,可通过 ArcGIS 加载 OBJ4CityEngine 外包工具,将 OBJ 模型转换为 CityEngine 可完整呈现的高精度高仿真三维模型。

2.3 场景整体制作

本文利用 CityEngine 软件进行室外批量建模,通过编写 CGA 规则对建筑群进行快速批量构建。具体制作流程为:①创建 CityEngine 工程,导入 ArcGIS 校园矢量专题图层,并针对各类专题图层编写 CGA 规则,实现自动批量三维建模;②导入已制作的 SketchUp 精细三维模型组件(建筑物模型创建、道路模型创建、绿化区创建、路灯与标志性建筑物创建),可展现较全面、完整、逼真的大规模校园三维场景(图8)。



图8 CityEngine 三维场景创建效果

2.4 室内外一体化制作

本文将 SketchUp 软件制作的校园图书馆室内外精细三维模型组件准确定位导入 CityEngine 三维场景中,体现了集微观模型和宏观场景于一体的三维效果(图9);并可根据展示需求,设置浏览路径,录制三维动画视频,以供数字校园宣传展示、校园动态规划建设所用。



图9 校园室内外一体化三维模型

3 结语

本文以扬州市职业大学为例,重点阐述了室内外一体化三维数字校园设计与实现过程中的原理和技术;同时验证了无人机技术、三维可视化技术在三维校园宣传展示、校园动态规划建设等方面的应用,为教育事业提供了崭新的思维方式和技术手段。

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improve the efficiency of field work and avoid the repetition of work and rework.

Key words the third time, territorial survey, interior work data, ArcGIS (Page: 97)

Application of Portable Panoramic Equipment in Urban 3D Panoramic Construction

by HUANG Mingwei

Abstract Most of street view data are acquired by the vehicle 3D panoramic measurement system. However, in places where vehicles cannot enter, such as narrow streets, hutongs, scenic spots, aerial scenes and indoor scenes, vehicle panoramic data cannot be collected. In this paper, taking Jiangba Ancient Town of Huai'an City, Jiangsu Province for example, based on portable panoramic equipment technology, we carried out the research of urban 3D panoramic construction. The result shows that the solution adopted can meet the application need of the digital cities.

Key words 3D panoramic technology, portable panoramic equipment, low altitude UAV, Digital City (Page: 100)

Indoor and Outdoor Integration 3D Model Production of the Digital Campus

by XU Yan

Abstract In this paper, we used UAV surveying and mapping technology to carry out campus aerial photography, and produced DOM and DLG of campus by photogrammetric software at first. And then, we used the rangefinder to accurately measure the indoor structure and attribute information of building, combining with SketchUp 3D modeling software, drew the accurate indoor plan of building, and built the iconic indoor and outdoor fine model. Finally, we used CityEngine and SketchUp to realize the integration of indoor and outdoor 3D model of campus, which could improve the publicity of campus and promote the construction of campus informatization.

Key words UAV, CityEngine, SketchUp, the indoor and outdoor integration 3D model, Digital Campus (Page: 103)

Research on the Application of Leica TS30 Total Station in the Plane Displacement Monitoring of Bridge Piers

by ZHANG Hongxiang

Abstract Taking the project of the Rizhao-Puyang-Luoyang crude oil pipeline under the Zhengjiao intercity high-speed railway built by Sinopec for example, we described the application of the Leica TS30 high-precision total station in the plane displacement monitoring of bridge piers, which in the excavation of the foundation pit near the high-speed railway bridge pier. The survey construction scheme is a free-standing station on site, which based on the principle that the rear intersection of four known control points is to be oriented, and the distance between the instrument stand and the monitoring point is about 60 meters. Then, the piers are monitored and measured according to the serial observation of monitoring points. The Leica TS30 high-precision total station is used to monitor the relevant high-speed railway bridge piers, which can quickly and accurately monitor the data information of the plane displacement changes of high-speed railway bridge piers.

Key words Leica TS30 high-precision total station, high-speed railway bridge pier, plane displacement, rear intersection (Page: 106)

Research on Rapid Surveying and Mapping Method Based on Phantom 4 RTK

by QIN Jiaxin

Abstract In the Spring Festival of 2020, COVID-19 suddenly broke out. Traffic control, personnel isolation and other measures had been implemented. It brought a series of challenges to the urban basic surveying and mapping. In this paper, we presented a rapid surveying and mapping method based on Phantom 4 RTK. In this method, we used vertical and oblique photographs to generate DSM, DOM, point cloud data and 3D model. Then, we used 3D model and DOM to produce topographic map. Experimental results show that the method can meet the accuracy requirement of 1 : 500 topographic map, and have good efficiency and applicability.

Key words COVID-19, UAV, Phantom 4 RTK, basic surveying and mapping, topographic map, image free control (Page: 109)

Establishment of the First Stage Ground Control Network of Subway and Its Precision Analysis

by DI Gang

Abstract In this paper, we introduced the layout, field observation, baseline processing, adjustment calculation and precision analysis of the first stage GPS control network for the first stage project of Zhengzhou subway line 3 in detail, and summed up the experience of the whole project.

Key words control network layout, stability, baseline processing, control network adjustment, accuracy analysis (Page: 113)

Design and Application of Spatio-temporal Data Conversion Service System

by CHENG Yuxiang

Abstract At present, the application of spatio-temporal big data is more and more widely, but in the process of converting non-spatio-temporal data to spatio-temporal data, there are many problems to be solved about high manual dependence, low conversion efficiency, spatio-temporal data big efficient storage. In this paper, through the construction practice of Chongqing spatio-temporal big data service platform, we summarized and put forward 4 kinds of spatio-temporal data conversion modes. And then, we realized the automatic whole process service consists of data access, conversion, management, analysis, service and application by studying the key technologies, such as process conversion automation, spatio-temporal big data storage, spatio-temporal big data calculation, spatio-temporal big data analysis.

Key words spatio-temporal data transformation, process conversion automation, conversion mode, spatio-temporal big data storage (Page: 116)

Research on Control Strategy and Technology of Feature-level Map Service Authority

by FENG Tuliang

Abstract The current ArcGIS Server map service authority management system can only control whether users have the authority to access certain service, and cannot control the feature-level access of features in the specified area of map service. In order to solve this problem, based on SOI extended development interface and OpenCV open source image processing technology, we proposed a feature-level map service authority control strategy based on ArcGIS Server, and implemented the technology. Experimental result shows that through this control strategy, the management of map service authority can be strengthened and the map service authority control can be refined to feature-level granularity.

Key words ArcGIS Server, SOI, map service, authority management, feature-level (Page: 119)

Internet POI Data Crawling Based on Python

by DENG Xiaobin

Abstract With the rapid growth of the Internet, point of interest (POI) data is widely distributed on the network. However, in the face of the huge amount of POI data on the Internet, it is difficult to download and organize the data by traditional manual methods, which has hindered the development of many services for POI data. In this paper, taking Python as the programming language, taking Baidu map as the platform, we built a new Internet POI data crawling method framework. Then, taking Nanchang restaurant POI data crawling for example, we carried out an experiment. The experimental result shows that the crawled POI data are real and valid and far more efficient than traditional manual survey methods, which can provide good methodological ideas for POI data acquisition.

Key words POI, Baidu map, Python (Page: 123)

Application of Traceability Management in the Management of Secret-related Geographical Information

by FAN Zhijian

Abstract Traceability management puts forward new requirements for the management of secret-related geographical information (MSGI). Combining with work practice, we discussed the application of the traceability management in MSGI, and pointed out the problems faced by MSGI at present and the measures to solve them. This study has certain guiding significance for improving MSGI.

Key words traceability management, secret-related geographical information, MSGI (Page: 127)

Research on Fire Safety System Architecture and Its Key Technologies Based on 3D Visualization

by CHEN Yang

Abstract In this article, we introduced the fire safety warning and prevent system based on 3D visualization, and explored the key technologies of fire safety, which could make fire safety supervision and inspection more transparent, control the fire hazards dynamically and assist to complete the firefighting and rescue tasks. This study can help the social units to fulfill their obligations of fire safety, and provide a way to redeploy resources reasonable for fire department.

Key words 3D, visualization, fire safety, building (Page: 130)

Design on the Route Selection Scheme of Large-cargo Transportation Based on the Restriction of Height and Weight

by QIN Han

Abstract The existed large-cargo transportation scheme only takes distance, time, and transportation costs as weight values involved in analysis and calculation of path selection. However, for super-high and overweight transport vehicles, the restriction of height and weight of the road is also a consideration. By introducing the classical Dijkstra algorithm into a road network model, we generated an auxiliary network based on the restriction of height and weight to participate in the shortest path analysis. And then, we obtained an optimal path considering transportation cost, height and weight restrictions. The method can demonstrate a favourable adaptability to complex and diverse road network situations, and provide a reliable basis for the route selection of large-cargo transportation.

Key words large-cargo transportation, restriction of height, restriction of weight (Page: 133)

Optimization of Atmospheric Weighted Mean Temperature Model in Qingdao

by FAN Shijie

Abstract Atmospheric weighted mean temperature is a key variable in the inversion of atmospheric precipitable water vapor in GNSS meteorology, and its accuracy has an important influence on the results of water vapor inversion. In this paper, based on the sounding data in Qingdao station from 2013 to 2017 provided by IGRA, taking into account the single factor, double factors and periodic error correction, we used the single station modeling approach to construct and optimize the atmospheric weighted mean temperature models. Then, taking the sounding data in Qingdao station from 2018 to 2019 and the ECMWF model data as references, we analyzed the accuracy of the localized optimization model. The results show that the Qingdao localized optimization model basically eliminates the influence of periodic errors, and its accuracy is better than the existing models.

Key words atmospheric weighted mean temperature, model optimization, periodic error, surface temperature (Page: 136)

Development of Intelligent Terminal Software in CGSsafety System Based on Android

by CUI Fangzi

Abstract The geological survey safety production management support (CGSsafety) system is closely related to the safety of field geological survey, and is of great significance to protect the life and property safety of geological survey operators. However, due to the constraints of time and space, it is difficult to meet the requirements of professionals to carry out work related to CGSsafety system anytime and anywhere. Based on Baidu map API, location based service (LBS), Hybrid App and other key technologies, we expounded the overall design, key technologies and implementation process of intelligent terminal software in CGSsafety system, so as to realize the real-time monitoring and control of field geological survey operators, vehicles, ships, aircraft and real-time interaction with operators.

Key words geological survey, real-time monitoring, intelligent terminal, Baidu map API, LBS, Hybrid App (Page: 139)

Discrimination of Rural Hollowing and Optimal Design of Homestead in Fogang County

by HU Sibin

Abstract Taking Fogang County in Qingyuan City as a typical analysis area, we studied the hollowing degree of Fogang County, and put forward the optimal design scheme of hollowing treatment. In this paper, based on the rural cadastral survey data and the high-resolution Luojia-1 nighttime light data, we used the entropy weighting judgment method to distinguish the hollowing of the villages in Fogang County. Then, we proposed a rural hollowing treatment scheme and rural homestead optimal design system. Finally, we put forward some transformation strategies and suggestions for the intensive development of rural hollowing, which could provide an application demonstration for the in-depth mining of the survey results of rural homestead in Guangdong Province, and further promote the implementation of the rural revitalization strategy.

Key words rural cadastral survey data, rural homestead, rural hollowing, Luojia-1 nighttime light data, homestead optimization (Page: 143)