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Research on Visualization of Digital Ground Model Based on Satellite Image

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Abstract: 3D printing technology has the advantages of high precision, low cost and environmental protection, and can provide a new and reliable technology for visual expression. This paper takes Qinghai Lake as the research object, uses remote sensing technology as the means to make a digital ground model, uses 3DMax software to convert geographic information data into data that can be visualized and expressed, and finally uses 3D printing technology to make a visual 3D solid model of Qinghai Lake basin. The experiment shows that 3D printing technology is feasible in the production of digital terrain model, and has broad prospects for development.

Keywords: 3D printing technology; Digital ground model; Visualization

Introduction

The 3D image simulated by geographic information data cannot convey solid 3D information to people in practical application. Therefore, an innovative manufacturing technology is needed to solve the problem of solid modeling and manufacturing of geographic information data. 3D printing technology [1], as a new process that can realize the materialization of 3D models, has the advantages of high model accuracy, short production cycle, low production cost, convenience and environmental protection. First of all, the high accuracy of the model perfectly compensates for the shortcomings of the complex river course 3D visualization model and the manual physical model. The 3D printed complex river basin physical model can more truly, intuitively and comprehensively reflect the current situation of the complex river basin topography. Secondly, 3D printing technology can not only reduce manufacturing costs, but also can not be affected by the complexity of product structure, the shape of the traditional process production of items will be constrained by the function of the equipment, 3D printed items will not face such problems, the most basic production principle of 3D printing is to superimpose the material layer by layer, the remaining material after the molding of the item can be reused. To make the next product, there is almost no waste and no harm to the environment; Finally, color 3D printing technology can manufacture DEM three-dimensional terrain data into a real actual model, giving full play to the simulation function, information carrying function, information transmission function and cognitive function of geographic information data, which is of great significance in practical applications such as military exercises, sand table manufacturing, and farmland planning.

1. Study area and data source

Qinghai Lake is located at the junction of Gangcha County, Gonghe County and Haiyan County, Xining City, Qinghai Province. Its longitude ranges from 99.58° to 100.77° East longitude and latitude ranges from 36.52° to 37.24° North latitude. The area is characterized by diverse hydrological conditions, rich soil types, complex topography and fragile ecological environment. This paper searched the location of the region in Bigmap GIS Office software and downloaded the satellite map of the selected region. In order to ensure the clarity of the satellite image, the download level was selected to 17. Then, open the website of geographic data spatial cloud (https://www.gscloud.cn), select DEM digital elevation data from the data set, then select latitude and longitude, enter the corresponding latitude and longitude, and finally download the elevation data of the region.

2. Digital elevation model making

2.1 Splicing and clipping of DEM raster data

First, open the ArcGIS software, open the downloaded DEM raster data in the software, load the DEM data, select 16_BIT_SIGNED pixel type, and select 1 band number. Then open the downloaded satellite image (tif format) in the software, search for "raster processing" in the search bar of the toolbox, select "Crop" in the raster processing, and load the satellite image first after opening, and then load the DEM raster data that needs to be clipped, check the use of input elements clipping geometry, and finally select the path to save the output position.

In this way, the DEM data (in adf format at this time) is clipped.

2.2 File Format conversion

First, in QGIS, load the elevation data in adf format and select "Export" to save it as tif format. Then open Blender software, import elevation data raster image (tif format), select "DEM as displacement texture mode", import satellite map image (tif format), and select "Basemap onmesh mode"; Then, when the model is selected, press Tab key to enter the editing mode, press A key to select all, then use the right mouse button to subdivide, select the number of cuts as 3, and finally press Tab key to exit the editing mode, ensuring that the operation is carried out according to the style shown in Figure 1; Finally, select Export STL format from the file options.

2.3 Transformation of solid model

First of all, open the 3dsMax software and import the STL file model into the 3dsMax software. Since there are multiple objects on the surface of the model, we need to integrate it into a whole first. Then click the right mouse button to select the model, convert the model into an editable polygon, and enter the required extrusion height; Then select the boundary, click "z" through planarization, and turn the following four curved boundaries into straight lines. In the same plane, click the seal in the Edit boundary tool box, and then the solid model will be formed, as shown in Figure 2.

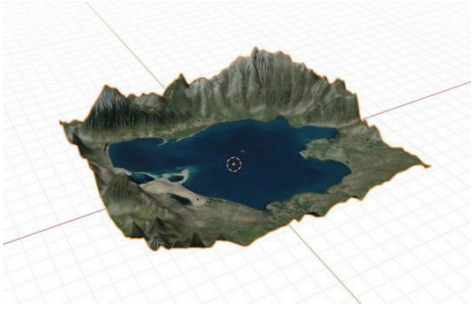

Figure 1 3D model around Qinghai Lake

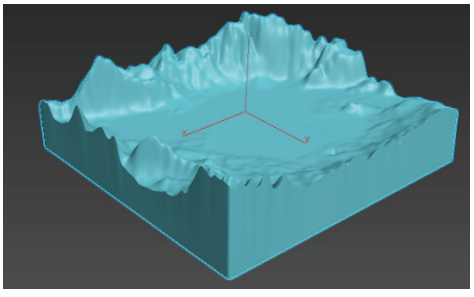

Figure 2 Transform the solid model

3. Model visualization

3D printing technology [2] is based on the STL format of the 3D model digital file as the interface. On the basis of the 3D model digital file, the model is layered, and then combined with various adhesive materials for heating. From the bottom layer to the top layer, the information layered by the computer is superimposed through the nozzle device, and finally a solid physical model is formed.

4. Accuracy evaluation

The accuracy evaluation adopts the three-dimensional coordinate measurement method combined with the root mean square error (RMSE) evaluation method, which collects the three-dimensional data of the solid model, processes and analyzes it, and then evaluates the accuracy. The main indicators of 3D printing accuracy evaluation [3] include dimensional accuracy, shape accuracy and surface roughness. The specific process is as follows: First, obtain the coordinates of the virtual 3D model in 3dmax software, and then use 3dmax to measure the coordinates of the two edge points of the model, so that the three-dimensional coordinate difference can be obtained, and the coordinates can be restored according to the scaling ratio. Next, the 3D coordinate measuring equipment corresponding to the optical principle is used to measure the coordinates of the real model and compare them. Data processing and analysis is the key link of 3D coordinate measurement, including preprocessing such as denoising and eliminating outliers, coordinate conversion and size calculation of the pre-processed data to obtain the measured values of each size parameter. The root mean square error formula is used to calculate the design theoretical value. The formula is as follows:

$$RMSE = \sqrt{\frac{\Sigma (x_i - y_i)^2}{n}} \quad (1)$$

Where n is the observed number, x_i is the predicted value, and y_i is the actual value. The smaller the RMSE value, the smaller the difference between the predicted value and the true value, and the better the model performance. Finally, the measured value is compared with the design theory value, and the reason of the deviation is analyzed to provide a basis for the improvement of the model size, so as to obtain the model that best conforms to the accuracy evaluation.

5. Conclusion

This paper takes Qinghai Lake as the research area, and uses 3D printing technology combined with digital ground model to model and display the terrain. By making a terrain model, the terrain feature information around Qinghai Lake can be visually seen, which provides a new and reliable technology for visual expression.

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