

Design and Realization of Block Level Augmented Reality Three-Dimensional Map

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Abstract

In response to the construction needs of “Real 3D China”, the system structure, functional framework, application direction and product form of block level augmented reality three-dimensional map is designed. Those provide references and ideas for the later large-scale production of augmented reality three-dimensional map. The augmented reality three-dimensional map is produced based on skyline software. Including the map browsing, measurement and analysis and so on, the basic function of three-dimensional map is realized. The special functional module including housing management, pipeline management and so on is developed combining the need of residential quarters development, that expands the application fields of augmented reality three-dimensional map. Those lay the groundwork for the application of augmented reality three-dimensional map.

Keywords

Augmented Reality Three-Dimensional Map, Multi-Source Data Fusion, Three-Dimensional Analysis, Three-Dimensional Scene, Skyline

1. Introduction

As a kind of graphic language form for recording geographic information, the map could show the physical world and is an important means for people to know the objective world [1]. With the rapid development of computer technology, three-dimensional data acquisition technology, dynamic visualization of massive data, 3S technology, virtual reality and oblique photography, the traditional two-dimensional map is injected new vitality, and the three-dimensional map is becoming an important direction of map development.

Around the data acquisition, data processing, data organization, data repre-

sentation and data application of three-dimensional map, the manufacturing method, manifestation, design and compilation principle and cartographic generalization of three-dimensional map was studied by many scholars in last decade. The methods of three dimensional map storage based on geo-referenced image database was researched in [2]; Combining the Skyline, Sketchup and 3dsMax software, the manufacturing method of urban three dimensional map was explored in [3] [4] [5] [6]; The making method for three-dimensional geographic information system of specific target area was expounded from the view of data application in [7] [8]; The influence of FOV and viewing angle on the visual information processing of 3D maps was analyzed combining three dimensional map symbol in [9]; The symbol design, label configuration and model of light and shadow of three dimensional map was studied from the aspect of spatial cognition in [10].

Around the design and realization of augmented reality three-dimensional map in large scale, the system structure, functional framework, application direction and product form of augmented reality three-dimensional map is designed combining the needs of comprehensively promoting the construction of “Real 3D China” [11]. The augmented reality three-dimensional map is produced based on skyline software. Including the map browsing, measurement and analysis and so on, the basic function of three-dimensional map is realized. The special functional module including housing management, pipeline management and so on is developed combining the need of residential quarters development, that expands the application fields of augmented reality three-dimensional map. Those lay the groundwork for the application of augmented reality three-dimensional map in small area such as campus, residential areas and so on.

2. Design of Block Level Augmented Reality Three-Dimensional Map

Using the augmented reality three-dimensional map as basic platform, the block level augmented reality three-dimensional map should be a visual multidimensional information system integrating the real map, residential quarters information, management planning and simulation, and has the basic function of traditional digital map including the accurate measurements, fixed point plotting, and the analysis of slope, light and shadow. And the new fresh including three-dimensional model and multimedia data should be fused with the 4D (DEM, DOM, DLG and DRG) product. Then the custom application functions including housing management and pipeline management should be developed. At last, the achievements of block level augmented reality three-dimensional map should be provided users with a system plus data. Based on the above ideas, the functional framework of block level augmented reality three-dimensional map system is designed as three layers structure, as shown in **Figure 1**.

The data layer is responsible for the running of data in system, including Basic surveying and mapping products, information database and three-dimensional

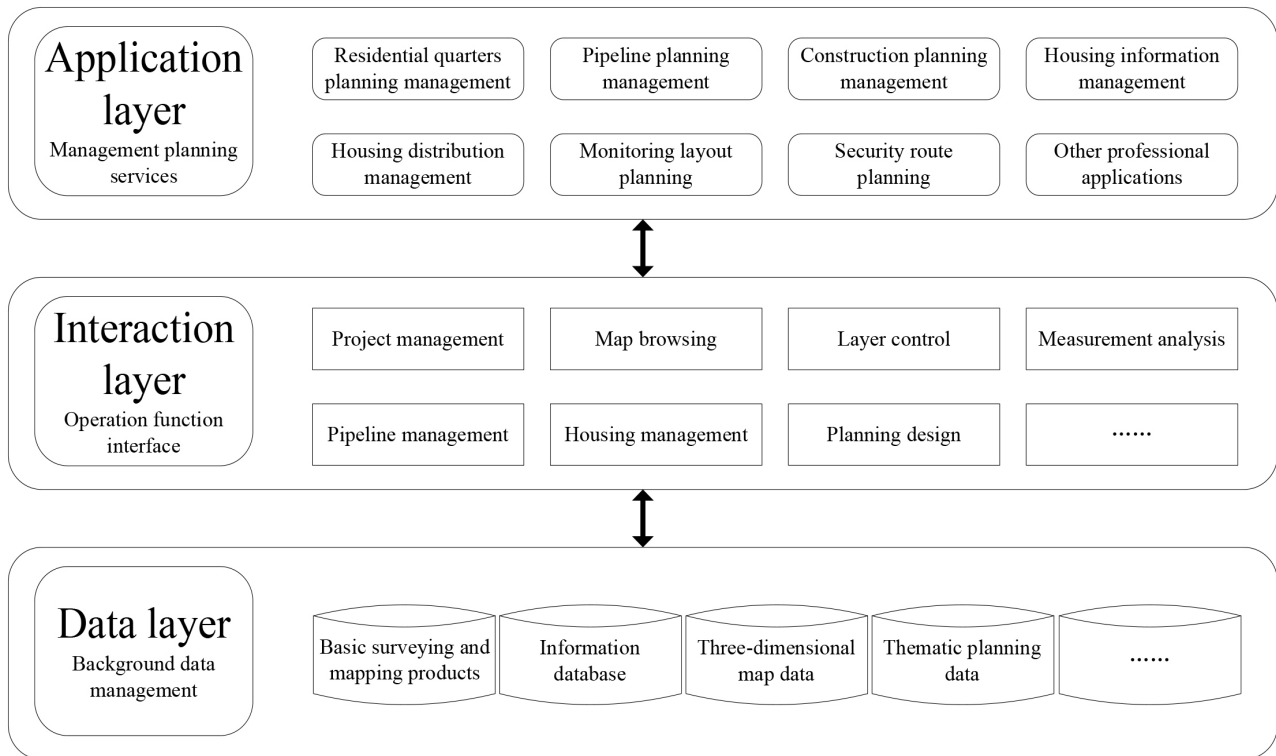


Figure 1. The functional framework of map system.

map data; The Interaction layer is used for human-computer interaction and provides friendly interface; The application layer is in charge of Residential quarters management and provides the Residential quarters planning management service and professional application.

2.1. System Development

The framework of block level augmented reality three-dimensional map is built based on the above functional framework of map system, as shown in **Figure 2**; Based on Skyline, the basic functions of three-dimensional map are developed, and the custom application functions including pipeline management and housing management are also developed combining the database.

2.2. Building Augmented Reality Three-Dimensional Map

According to the technical requirements of photogrammetry, the aerial triangulation is completed, and the basic surveying and mapping products are produced; The real photos are collected according the requirements of three-dimensional modeling, and the three-dimensional models are built and rendered in 3dMax software; Based on Skyline software, the three-dimensional scene is built integrating DEM, TDOM and three-dimensional model; According to the application requirements, the information of personnel, building and pipeline is collected and loaded into database, and the augmented reality three-dimensional map is built finally.

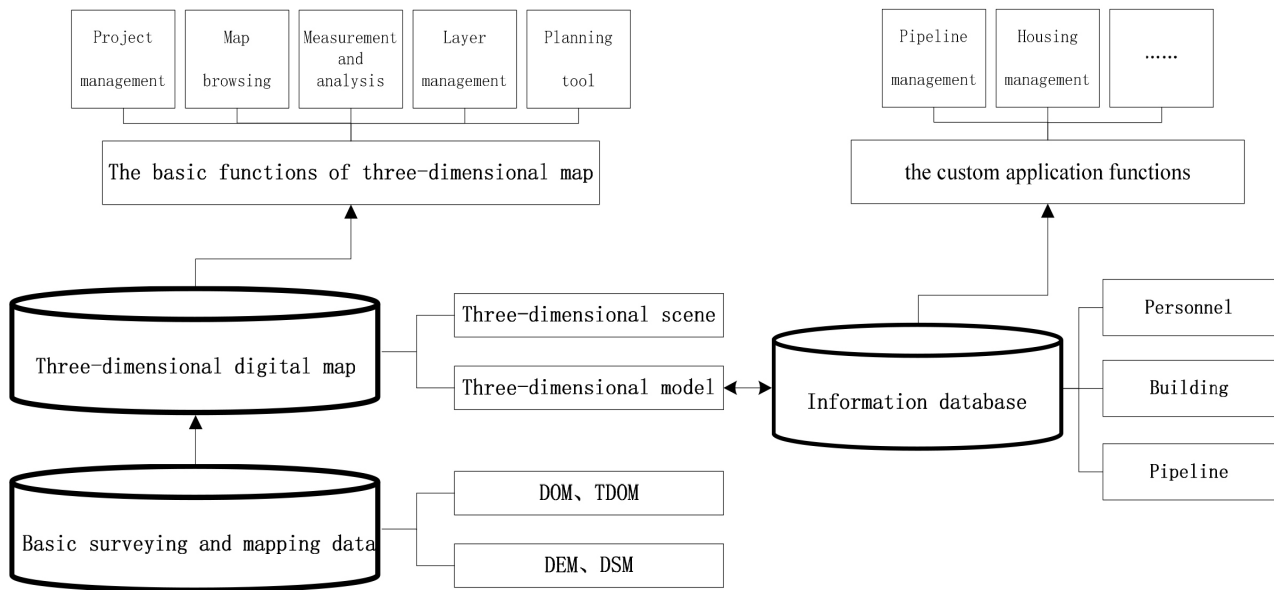


Figure 2. The framework of block level reality three-dimensional map.

3. Realization and Application of Block Level Augmented Reality Three-Dimensional Map

According to the functional design requirements and application requirements of block level augmented reality three-dimensional map, the basic functions including project management, layer management, map browsing, measurement and analysis and design tool are realized using C# language based on the SDK of Skyline software; the custom application functions including pipeline management and housing management are realized combining Microsoft SQL 2008 database. The following will focus on measurement and analysis, design tool, pipeline management and housing management.

3.1. Measurement and Analysis

The function of target measurement, terrain analysis and spatial analysis is realized in the measurement and analysis module. The target measurement function includes horizontal distance measurement, vertical distance measurement, spatial distance measurement area calculation and so on, as shown in **Figure 3**; The terrain analysis function includes slope calculation, terrain profile, calculation earthwork calculation and so on, as shown in **Figure 4**; The spatial analysis function includes visibility analysis, viewshed analysis and so on, as shown in **Figure 5**.

3.2. Planning Tool

The planning tool module contains video capture, text annotation, terrain modification, add line, add polygon and so on, and combining with the measurement and analysis module, the engineering plan can be designed and simulated in the augmented reality three-dimensional map system, as shown in **Figure 6**.



Figure 3. Sketch map of target measurement.



Figure 4. Sketch map of terrain analysis.

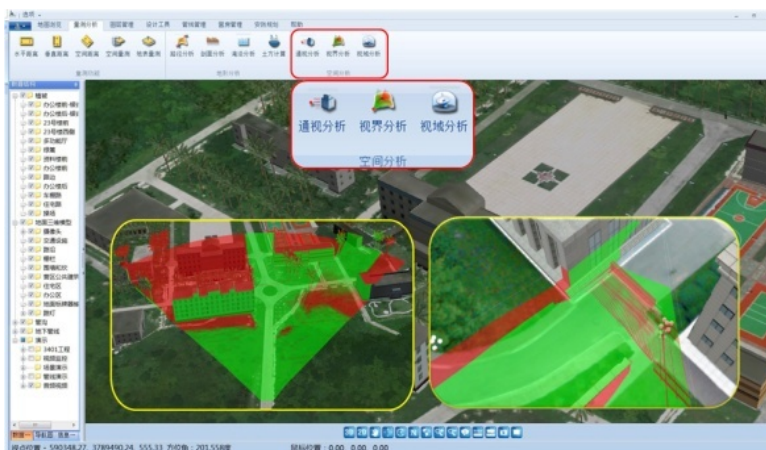


Figure 5. Sketch map of spatial analysis.

This module has been applied in an engineering planning. Combining the measurement and analysis module, the building earthwork was calculated. And the building, planting and road were simulated. At last, the shadow, lighting and visibility of building were analyzed in the actual scene.

3.3. Pipeline Management

Achieving the interactive operation between three-dimensional scene and pipeline database, the pipeline management module is used to management residential quarters underground pipeline data. Through this module, the user can browse, measure, query and modify the residential quarters underground pipeline data in the three-dimensional scene, as shown in **Figure 7**.

3.4. Housing Management

Linked with three-dimensional map, the building information database can be queried and maintained in housing management module. And the relation graph of building information database is showed in **Figure 8**. Through this module, the user can query the building structure, occupancy, household information and past household information and so on. And the housing allocation function can be realized by the interactive editing of database, as shown in **Figure 9**.



Figure 6. Sketch map of planning tool.



Figure 7. Sketch map of pipeline management.

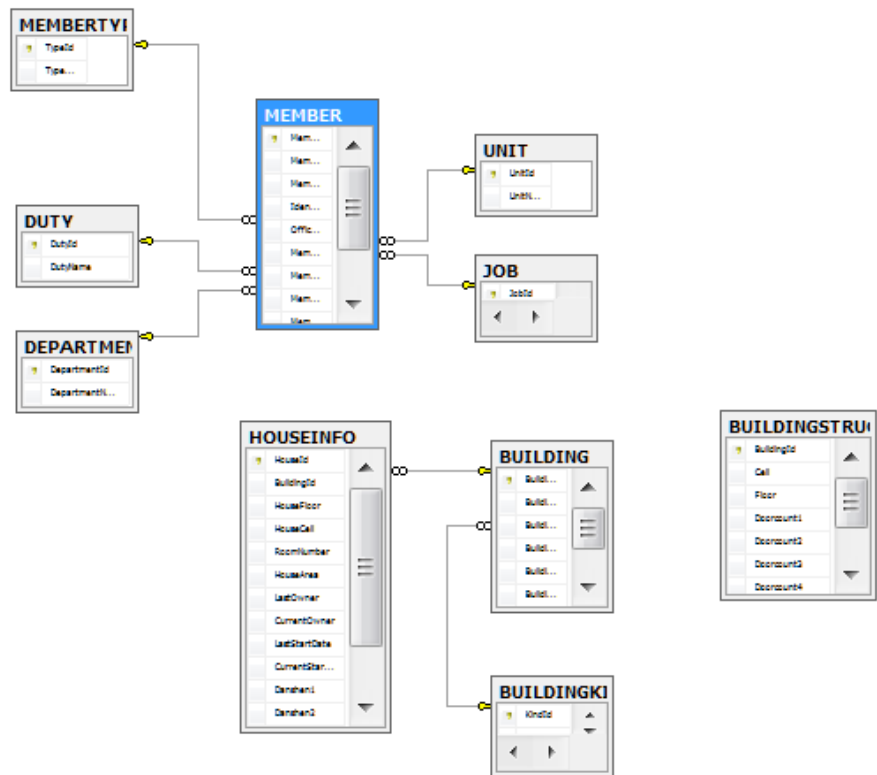


Figure 8. The relation graph of building information database.

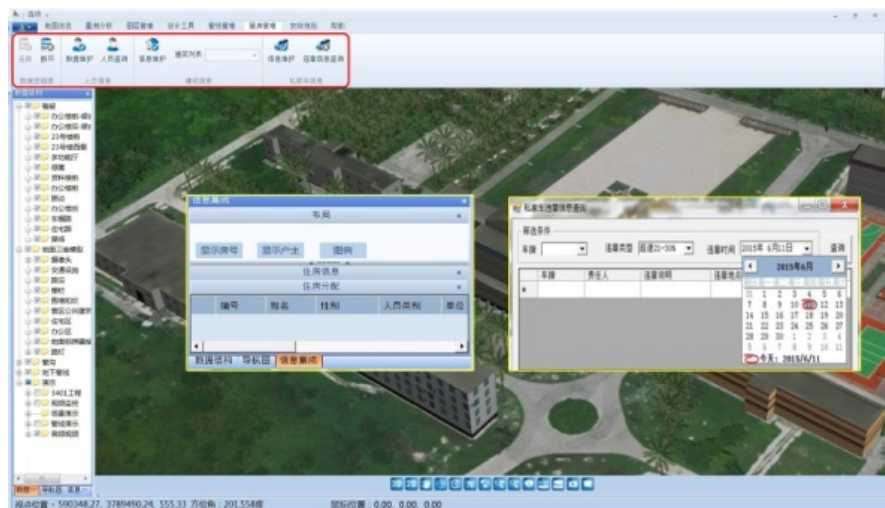


Figure 9. Sketch map of housing management.

4. Conclusions

Around the research of design, realization and application of block level augmented reality three-dimensional map, the system structure and functional framework was designed; The multi-source data of augmented reality three-dimensional map was integrated in skyline software; The three-dimensional tools including the map browsing, measurement and analysis and so on were developed based on the SDK of skyline software; The custom application functions including

pipeline management and housing management were resized combining Microsoft SQL 2008 database; The augmented reality three-dimensional map system was built, that has rich three-dimensional functions and higher applied value in block information management.

However, the designed augmented reality three-dimensional map is made based on the Skyline software, so the security of map system is weak, especially the security of map basic data. Besides, owing to the need to connect to the database, the three-dimensional model must be single and have independent face, so it is difficult to build three-dimensional model automatically. Future study will focus on the security technology and automatic modeling technology.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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