Research on the Construction of City Information Modelling Basic Platform Based on Multi-source Data

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Abstract. The construction of city information modelling (CIM) is of great significance for the formation of a new smart city. In this paper, on account of UAV tilt photography, BIM model, Internet of things traffic data, to build a CIM platform under multi-source data, a pilot study was carried out in Tiexi New City. The development platform of Terraexplorer Pro based on the Skyline system is combined with the main technical support of BIM, GIS, and IOT to construct CIM. Its purpose is to achieve static and dynamic, ground and underground, indoor and outdoor integration, and provide prospects for future urban evolution. This study can contribute a reference for other CIM planning, and equip an effective scheme for smart city system planning and urban governance.

1. Introduction

With the rapid development of the information age, BIM has opened the first decade in the field of AEC (Architecture Engineering and construction). However, BIM is not enough to face the tasks of processing and managing a large amount of information flow data. The combination of BIM Technology and other technologies will convert the engine force of urban construction in the future. In this context, CIM, as an information technology means, provides a digital base for smart city manufacture. Academician Wu Zhiqiang pointed out that BIM is a monomer, CIM is a group, BIM is a cell of CIM, CIM is an extension of BIM. The research and development project of the CIM platform is approved to be included in the science and technology plan of the Ministry of Housing and Urban-Rural Development(MOHURD) in 2019; The National Development and Reform Commission (NDRC) listed CIM as an "encouraging" industry in the Guiding Catalogue of industrial restructuring; The MOHURD proposed that cities with the conditions could establish CIM that can hinge to BIM; Through the test in Guangzhou, Nanjing, Chongqing and other places, it shows that China has entered the primary stage of CIM platform planning.

Some scholars have expounded the concept of CIM. Xu et al. take the view that the establishment of CIM is the integration of BIM + GIS[1]; Wang Shen et al. consider that it is the superposition of data of architecture, infrastructure and geographic information[2]; Lee, S. H et al. stick to the opinion that CIM includes buildings, road and bridge facilities and terrain [3]; Wu Zhiqiang assume that CIM is an organic synthesis of urban dynamic information under the unified integration mode of micro BIM model, macro geospatial data (GSD) and Internet of things (IOT) data; Scholars mostly discuss the basic elements of urban composition. Despite the fact that they have diverse perspectives, their basic concepts are consistent- They use the core data of the city to provide services for more intelligent urban construction.
2. CIM Framework

2.1. Project Overview
The project is located in Tiexi of the Shenyang, with a total planning area of 484 square kilometers and a total population of 1.14 million. There are thousands of single buildings, involving innumerable specialties, complex structure, and large volume.

2.2. Design Ideas
The objective of the Tiexi CIM platform is to contribute intelligent service for urban management and get the joint perception of urban static and dynamic, ground and underground, indoor and outdoor integration, and further improve the information service mode of the smart city. The system is mainly divided into 5 levels, and the architecture is shown in Figure 1.

Figure 1. CIM framework

The data collecting layer is to establish services for the data layer, mainly through two-dimensional code, RFID tags of sensors for real-time acquisition and offline acquisition. Real time acquisition is collected through flume, Kafka is used as cache. Offline cache is counted by MapReduce, and hive is used as data warehouse; In the data layer, 3D solid model, vector data, terrain, remote sensing image, video information and so on are taken as the fundamental data of CIM platform; The system framework stores vector and attribute data in Geodatabase spatial database as local files, 3D model and image data as local files, and real-time offline data are stored by HBase and Kafka respectively, and are compatible with Oracle relational database. The data service layer is similar to the brain center. It can meet the data requirements of the upper layer by calling the data and functions in the bottom layer. For example, the terrain data is released through Terragate platform, three-dimensional model data is vectorized into two-dimensional data, and dynamic display is realized by loading TerraExplorer Pro sticked to model flow technology. Vector data is mainly published in the form of WFS and SFS as web services. The data analysis layer mainly establishes the internal data standard and interactive method between BIM and GIS, and recognizes the effective amalgamation of BIM model and 3DGIS in Revit. The above-mentioned data frameworks can realize the following functions: (1) through the sequence of SOA technology and system architecture, the lightweight processing of BIM model [4]...
enables the model information to be quickly pushed to the manager by the cloud + Web terminal, so that the information model can be quickly and accurately displayed. It further meets the needs of engineering informatization; (2) It can establish mathematical decision modeling to acquire public opinion monitoring, early warning monitoring and problem positioning; (3) CIM platform construction provides intelligent health, medical, education and other services for the construction of smart city. (4) The platform links the real-time status data collected and transmitted by IoT[5] and the government data of enterprises and residents to establish interconnection and cross-domain interactive information, to assist in urban development and intelligent services for urban visual management.

3. Urban Multi-source Data and Fusion Construction

3.1. CIM Data System

At present, there are increasingly varieties of urban data. Not only are their data formats and sources diverse, but their processing methods are also different and constantly changing. It is indispensable to establish a CIM urban data resource system. The formation of data system is the core component of CIM platform. The city data include (1) It is mainly wedded to the real scene data of the tilt Survey Institute, and the ground model, underground space model and pipeline model obtained by Revit 2016 modeling. (2) IOT data (3) The basic geographic information data is an accurate description of the location of all kinds of surface features and is the basis of CIM data analysis and service. It includes DOM, DEM, terrain data, vector data, etc; (4) Social public data and Government sector data.

3.2. Data Construction and Fusion

At present, a three-dimensional model, geographic information, and IOT data have been obtained.

3.2.1. Three-dimensional terrain data. 3DGIS make the most of Skyline software as the platform. Terraexplorer is mainly utilized for scene integration, Terrabuilder builds 3D terrain data in. MPT format and Terragate makes full use of its own functions to publish services. The terrain data supported by the skyline is. MPT format, which is used as the 3D base map of the platform to display the macro 3D terrain information. Resorting to Terrabuilder to make MPT files requires an orthophoto map (DOM) and elevation data (DEM)[6]. Dom and other vector data are superimposed on the terrain skeleton, and then loaded with Terraexplorer and processed by coordinate transformation and registration to complete the display of the 3D ground model[7].

3.2.2. 3D spatial data. UAV tilt photography is used to obtain 3D spatial real scene data. This technology can not only truly reflect the situation of ground objects but also obtain high-resolution urban space basic data and 3D building model contour. In this paper, we take advantage of the wgs1984 coordinate system, and the scale accuracy is set as 1:500. In line with the given route parameters, aerial photography is carried out from different angles simultaneously. For dense areas, the overlapping degree of buildings can be designed as 80% - 90% to obtain an inclined image, and control points and checkpoints are arranged in the survey area. After field measurement, interior processing, texture mapping, and other processes, the 3D real scene model [8]-[9] is obtained.

3.2.3. Model of above ground and underground buildings. For the reason that the image captured by UAV is only 3D contour, it can not realize indoor and outdoor integration. BIM model is needed to make up for this defect and solve the data source problem of the 3D indoor building model. After the completion of Revit modeling, we should not only check whether the model is consistent with the actual scene, but also observe whether its position, size, advance and retreat hierarchical relationship conform to the status quo [9].

3.2.4. IoT data. Take the real-time perception of traffic media data by IoT as an example. The media data itself has no location data, and its audio, video, and photos are endowed with location data by reason of becoming the managed objects in urban construction. IOT will obtain the real-time dynamic data of the city through radio frequency identification (RFID), sensors, laser scanners, and other
sensor equipment as well as network interconnection technology. The back-end calls the database to feedback to the monitoring screen to realize the dynamic traffic supervision. It can analyze the traffic congestion, judge the average speed, and prepare for traffic safety emergency.

3.2.5. Data fusion. CIM data (including BIM model, image, video screen, etc.) has the characteristics of various formats, large span, multi-source, heterogeneous, time-varying, high-dimensional, and so on. Due to the differences in morphological structure, application field and spatial scale, data processing methods and standards are also completely different. Therefore, it is necessary to establish general storage standards and fusion standards.

In the past, the BIM model was used to organize data in consonance with IFC Standard or convert it into the GIS readable format. Even if the conversion is simple, it is easy to cause data loss. In this paper, the Visual C# net combined with the Revit API is used for programming. The BIM model in Revit is converted into FBX format or X file, which is acceptable to terraexplorer pro. It can further solve the problems of information error and loss, low coupling degree of geometric semantic information and poor application expansibility. DirectX supports the 3D visualization. X files, which is a common data format for the conversion from Revit and other software to 3DGIS. The transformation of BIM model includes the transformation of geometric information and attribute information [9]. By splitting the BIM model, based on the secondary development of Revit, and reconstructing according to the family (for example, BIM house model includes doors, windows, walls, columns, structural foundation, etc.). When exporting, you need to set the family color and store it locally in the form of X file.

GIS is a geographic space coordinate system. BIM coordinate system is the expression of logical relationship and spatial position among components in the model. To realize the transformation from BIM model to 3DGIS, a series of parameters need to be set. Taking a building as an example, this paper transforms its elevation, yaw angle, rotation angle, azimuth, scale factor and other information, as shown in Table 1, the integration effect is shown in Figure 2, and the fusion process is shown in Figure 3.

Table 1. Parameter setting

| Parameters                  | Basic Data               |
|-----------------------------|--------------------------|
| 1.Position                  |                          |
| Elevation Mode              | Absolute value           |
| Height                      | 78.9173960               |
| X Coordinate                | 123°39’07.745”           |
| Y Coordinate                | 41°47’36.067”            |
| Yaw Angle                   | 74.0000000               |
| Angle of Inclination        | 0.0000000                |
| Rotational Angle            | 0.0000000                |
| 2.Geometric                 |                          |
| Optimum LOD Size            | 1000.0000000             |
| Scale in X Direction        | 0.0254000                |
| Scale in Y Direction        | 0.0255000                |
| Scale in Z Direction        | 0.0245000                |
4. CIM Features
After the data network deployment and release are integrated with the model, the 3D GIS application system can be developed based on COM protocol components, using Visual Studio 2016 development tools and script language and ActiveX components provided by Terraexplorer Pro API, to realize the integration of ground, underground, static and dynamic, indoor and outdoor.

4.1. Integrated Display
The data management and visualization techniques of the above-ground and underground scenes can truly reproduce the urban terrain, landform, and the distribution of underground pipelines, and realize the integrated data linkage service, which can effectively solve the problem of the collision between the above-ground and underground buildings and make rational use of the underground space. If there are many uncertain factors in the safety problems during road construction, there will be certain construction risks. Through the underground browsing mode, the distribution of underground pipelines can be controlled. By simulating the uncertain factors of construction prediction in advance, the rework problems can be reduced, time can be saved and corresponding, measures can be taken in time to ensure safety.

4.2. Intelligent Aided Planning
In the construction process of the CIM model, BIM data is integrated to realize the analysis and visualization of planning and design simulation. It provides attribute query, positioning analysis, sunshine analysis, two-dimensional and three-dimensional visualization of planning land. In addition,
in urban construction planning, 3D perspective analysis plays an important role in urban planning. The purpose of view analysis is to judge the connectivity and visibility between buildings. Given a certain height of a certain point, the observation point can cover the line of sight of urban buildings, in which green is the visible area and red is invisible. Scientific and reasonable building horizon analysis enables some important scenic spots in the city to have a certain scale with the buildings around the landscape, thus protecting the visual effect of the scenic spot or landscape.

4.3. Smart Transportation
The splendid modeling of BIM gives the urban road network of GIS a deeper level of micro information. Different from the traditional traffic field, intelligent transportation can not only master the traffic behavior and traffic flow data of vehicles in the city, but also can click to locate the target point in the three-dimensional scene, analyze various problems such as traffic conditions and traffic accidents. It can also obtain the license plate number in real time and bind it with the dynamic object to play back the historical track. Based on the scene model, it can ensure the safe operation of the traffic network, and provide comprehensive technical details and road data scheme for the automatic driving of vehicle road coordination.

5. Concluding Remarks
CIM model is a combination of three-dimensional urban spatial model and urban information, which is the basic data of smart city construction. This paper describes the construction method of the CIM platform and summarizes the main issues in the process of model construction, which not only involves the integration of BIM data, IoT data, and remote sensing data but also discusses its design ideas and platform application.

The first step of CIM is only to realize digitization, followed by the gradual transformation of digitization into informatization, and finally, the realization of cross-sectoral informatization. There are still a sea of deficiencies in the interdisciplinary integration, in terms of data sharing support, we lack data on population, enterprises, education, health care and government. In the process of future urban construction, multi-source data fusion and sharing will be established to realize joint data management. It plays an important role in promoting the management of urban planning and construction, realizing the high-quality development of the city, assisting the construction of new smart cities, and comprehensively improving the refinement level of urban space governance.

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