Coding Technology of Building Space Marking Position

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Abstract. The data generated in the process of planning, construction, and management of construction and building is diverse and large in scale, and there is an urgent need for a unique, consistent, and efficient code. Beidou grid position coding stipulates its grid selection and coding rules, as well as spatial position information identification, transmission and big data processing, which can have good scalability in the field of building spatial identification position coding. Based on the coding rules of the Beidou grid position code, this paper proposes a construction building space identification position coding technology to code the construction building. The coding is unique, consistent and efficient. The application of coding rules is introduced in the paper, including code generation and coding index, as well as the corresponding query algorithm, which is verified by engineering experiments.

Keywords: Buildings · Space identification · Position code · Beidou grid

1 Introduction

There are many types of information about buildings and their components. From building design to later maintenance, additions, deletions and changes of information often occur, which brings challenges to the information management of buildings and their components.

In the design phase of the building, the digital information model of the building assigns a unique identification code to the internal components of the building, so as to exchange and manage multi-source data in the construction industry based on the identification code during the entire life cycle of the building. In recent years, the relevant national infrastructure construction departments have introduced a series of classification information codes for building and building components, but they have not paid enough attention to the spatial location attributes of the components. If the unique identification of the spatial location is used as the integration clue, the association of building components based on the spatial location can be realized.

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Since the building space location identification information is very important in file management, intelligent construction and later inspection [4], this paper proposes a set of building location codes to meet the application requirements of related industries. The spatial location division and coding system of this set of buildings inherits the Beidou global location framework and meets the following three main requirements: (1) Uniqueness requirements: each building has a globally unique identifier and can establish a one-to-one correspondence with the corresponding entity relationship. If the uniqueness is not satisfied, different departments assign different identification codes to the same building, and there will be deviations and misunderstandings in data integration and exchange, and the multi-source attributes of the object cannot be merged through the identification code. (2) Consistency requirements: The external environment of the building and the internal space of the building share a set of division framework and coding method, which is convenient for the expansion of the division framework and spatial calculation analysis; the spatial identification of different buildings is under a set of spatial identification naming framework, Organize and manage all building data. (3) High efficiency requirements: There is a large amount of component information in the building, and data association and retrieval need to be carried out through component identification. The component has a preset unique spatial location in the building, and there are many data sharing and data retrieval scenarios that take the spatial location as a clue in practical applications. To realize the application in these scenarios, the spatial identification code assigned to the component entity is required to support efficient and accurate topology analysis and distance calculation.

1.1 Research Status at Home and Abroad

Building Coding System. In 2006, the International Organization for Standardization formulated the ISO/IDS framework to establish the classification information standards of the construction industry in various countries, defined the basic concepts of various construction information classification systems, and sort out their relationships. The American Building Standards Institute CSI and the Canadian Building Standards Institute CSC have promulgated the Omniclass classification system, which can present the most intuitive and concise coding system, docking with the BIM data storage standard IFC, and supporting the realization of BIM technology [13, 17]. In 2018, the Ministry of Housing and Urban-Rural Development of the People's Republic of China issued the "Building Information Model Classification and Coding Standard GB/T51269-2017" applicable to civil and general building plants [1].

The component codes currently used in the construction industry mainly consider component types, geometric characteristics, production information, etc. A specific component/part produced in the same batch from the factory will be given exactly the same production code. Components scattered in different regions and spatial locations share a production code, so that the current component code cannot guarantee global uniqueness.

Component Query Method. The complexity of building components and the diversity of semantics make it difficult for users to retrieve expected results through keyword queries, and the accuracy rate is low. IFC's data model can be mapped to a relational database and transformed into XML or RDF expression. Researchers are committed to proposing various QL frameworks, such as SPARQL [7], XQuery [8], QL4BIM [9]. Lu Jin [18] of Beijing University of Architecture and Architecture pointed out that current research has played a role in promoting the retrieval of building information in BIM models. The simplified component is a mass point, and the path between the component and the user's reference point is sorted in the calculation, the shortest distance is obtained by Dijkstra algorithm, and an ordered set of components is obtained from the spatial relationship and distance.

1.2 Limitation Analysis

There are still four problems in the existing research on the sign and application of building space [19]: The spatial position representation of the components inside the building is based on the local reference coordinates; The position of the component depends on multiple reference systems, which does not satisfy the uniqueness and consistency of the spatial identification; The existing building codes are classified information codes, which only consider simple building object information and cannot directly contain the relationship of relative positions in the building; The information retrieval method of the existing component cannot directly place the spatial attributes in the index column and perform calculation and filtering operations on the content of the index column, which has low efficiency and does not satisfy the efficiency of spatial identification.

2 Overview of Beidou 3D Grid Position Coding

The Beidou grid position code specifies the grid selection and coding rules of the Beidou grid position code [6], which is widely used. It conforms to the following basic coding principles: a) uniqueness; b) nesting; c) compatibility; d) calculation; e) practicality.

Beidou 3D grid location code is composed of 2D grid division of the earth surface and grid division of height domain.

In the two-dimensional grid division of the earth's surface, the origin of the grid is at the intersection of the equatorial plane and the prime meridian, and the two-dimensional grid is divided into ten levels. The method is as follows: (1) The first level grid: according to GB/ T 13989-2012 is divided into 1:1 million map frames, and the unit size is $6° \times 4°$; (2) Second-level grid: divide the first-level $6° \times 4°$ grid into 12×8 second-level grids according to latitude and longitude, corresponding to $30' \times 30'$ grid, which is about the earth 55.66 km × 55.66 km grid at the equator; (3) Third-level grid: Divide the second-level grid into 2×3 third-level grids according to latitude and longitude, corresponding to 1:50,000 map The grid is $15' \times 10'$, which is approximately 27.83 km × 18.55 km grid at the equator of the earth; the rest can be deduced by analogy [20].

In the subdivision of the height domain, the arbitrary division number is m, and the height domain is divided into 2 m layers, with 2 m-1 layers underground and 2 m-1 floors above ground. The height of the same layer of the same level grid is equal, and the height matches the latitude direction length of the grid formed by the corresponding level division at the equator of the corresponding contour plane of the layer.

The grid height at the same level and the grid latitude length at the equator of the corresponding contour are shown in Fig. 1. The height domain of the Beidou 3D grid position code is divided, and ten basic grids of 4°, 30′, 15′,…, 1/2048″ on the earth's surface are used as the Beidou 3D grid position code to define the middle of the earth height. Form the height domain grid division: a) the initial grid, the above ground and underground are divided into two parts; b) the first level grid, using the same division as the length of the equator, each division is about 445.28 km; c) The second-level grid uses the same division as the length of the equator 30′, each division is about 55.66 km; the remaining levels are analogous to [16].

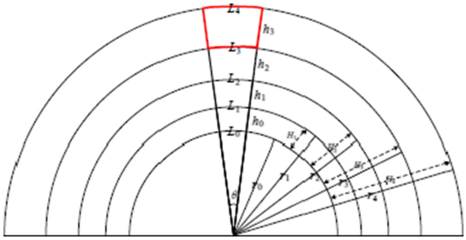

Fig. 1. The division method of unequal distance in the direction of the height domain (equatorial plane).

2.1 Meshing Dividing

2.1.1 Encoding Rules

Beidou 3D grid position code is composed of two-dimensional code + height-dimensional code intersection [21], a total of 32 code elements.

The Beidou 3D grid position code is composed of 12-bit code elements. The structure and code element values are shown in Fig. 2. The third dimension code is as follows:

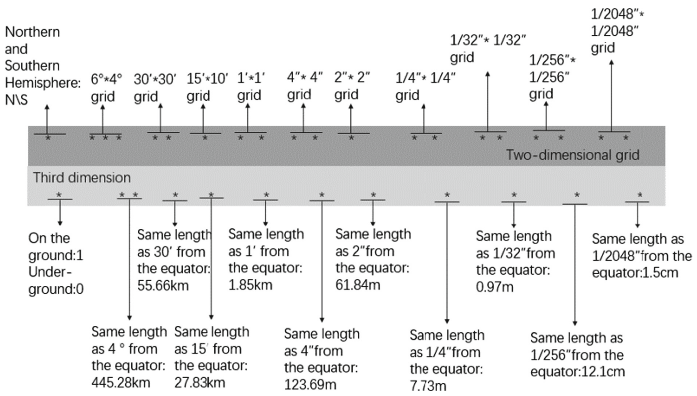

Fig. 2. The form of Beidou 3D grid position code.

3 Overview of Beidou 3D Grid Position Coding

To locate a building, it is necessary to locate the entire building and the internal component entities of the building [10]. The coordinate system outside the building is a rigid Beidou grid position system. The two axes of the plane coordinate are radial and latitude. The building takes the logo center as the positioning object, and is assigned a positioning code, which is organized and managed as a whole. The building itself is not only the subspace of the global grid system, but also the parent space of the internal information of the building. Inside the building, in order to ensure the expandability of the internal and external divisions, the external positioning marking points are the starting points of the division. After determining the starting point of the internal division, the directions of the two axes of the plane are also consistent with the two axes of the external global position coordinate system, which are true north and true east directions. The height dimension is divided according to the floor height of the building itself. The division of each floor also directly follows the existing area division in the building, and these sub-spaces will be assigned a positioning identification code on each floor. The sub-spaces of each floor are represented by a rectangular shape of uniform size. The entity eventually falls in a certain subspace, and the three-axis positioning is performed in the three-dimensional space.

3.1 Meshing and Coding Scheme

This section discusses the identification points of each level (building-floor-subspace), the division of grid levels, and the rules for coding after division.

Identification of the Entire Building. First, locate buildings on a global scale and perform unique spatial identification. To identify the building, choose a suitable identification point, and use the center of the ground projection range of the building as the identification point instead of the actual area occupied. The projection polygon is divided by the Beidou grid with a suitable level, and the inner corner closest to the southwest is selected as the landmark O of the building. In reality, the distance between buildings generally exceeds 8 m, and the seventh level (1/4′) of the Beidou grid code is selected for division [20].

After obtaining the identification point, identify the point in the global position frame. An administrative region organization will manage the data of multiple buildings, and the administrative center where the building is located is selected as the reference point for positioning. Determine the administrative division center and building identification points, establish a two-dimensional plane coordinate system, determine the position of the entire building in this coordinate system, and select the appropriate level L to determine the number of grids M, N to span (Figs. 3 and 4).

In order to avoid that the identification points of the two buildings fall on the same grid and lose their uniqueness, a grid of appropriate size is selected so that the side length is not greater than the distance between the two. The 7th level grid is more suitable [20], but when the distance is too far, the length of the code will be lengthy. If a smaller level is introduced, although fewer span codes can be used, the level's mark must be added. In order to balance the number of span grids and the identification bits

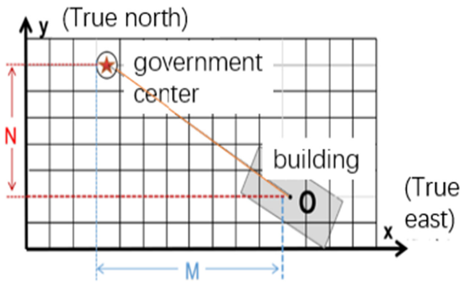

Fig. 3. The positioning process of the whole building.

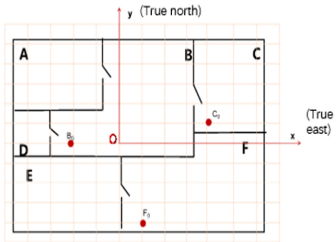

Fig. 4. Subspace identification point determination.

introduced for the level identification, in addition to the seventh level, another level is selected to jointly identify the span. The maximum two-digit seventh-level grid can cover a length of $24.75° < 1'$, so the fourth and seventh levels are selected to jointly identify the span. The offset of the building relative to the administrative center is negative. M and N should contain a negative sign to distinguish the relative direction.

Division and Coding of Building Floor Height Dimension. Considering the division of the height dimension of the building, the starting plane of the division is specified on the ground in the building. The upward direction is the positive direction of the height axis, and vice versa. The internal space of the building is generally distributed in different floors, but it is also If there is a staircase with a corner between two floors, it is stipulated that these facilities are divided into the floor space below them.

The tallest building in the world, Burj Khalifa, has a total height of 828 m, 162 floors above ground and 169 floors underground. The number of underground floors generally does not exceed 162. The floor code consists of five digits in total: the first digit represents U or D on the ground, and the last three digits are the number of floors. For example, U021 means 21 floors above ground, D002 means 2 floors underground, and so on.

The building code is extended to the floor height as:

$$C\_0MN - F \tag{1}$$

Floor Plan Division and Subspace Location Code. In each floor of a building, many components need to be further divided into space to obtain a more refined space to determine the precise location of the components. In order to meet the principle that the external division can be extended to the interior, the origin O adopted is the identification point selected when positioning the entire building. The x and y axis directions of the internal coordinate system are respectively selected as the true east, true north, and z axis. The direction adopts the growth direction of the building's floors, and each floor height is an independent floor coordinate system. We further divide the entire floor to obtain subspaces, and locate and code the subspaces in the floor plan coordinate system. If one vertex of the polygon of the horizontal plane of the space is selected, it may happen that multiple spaces share one identification point.

To determine the identification points of the subspace, first select the level, and select a grid with a side length of 1 m to divide the molecular space. Each space is divided by multiple grids, and the corners of the grid are in the space. We choose the corner point closest to the origin of the floor coordinate system as the identification point of the subspace, and the positioning points of the subspaces B, C, and F are obtained as B0. C0, F0.

After the identification points of each subspace are obtained, their true north and true east offsets in the floor plan coordinate system are M′, N′ respectively. The location code for constructing the building code to extend to the subspace level is:

C_0 MN-F-M^' N′ (2)

Division and Coding in Subspace. Each subspace in the floor plan coordinate system has its own independent coordinate system constructed inside, and they are related by the floor plan coordinate system, and the offset of the respective subspace identification point from the floor identification point is used as the identification code. The components are divided in three dimensions within the subspace to accurately locate them.

In the three-dimensional subspace, a certain component in the floor is located further and more accurately. Some components are very close to each other, and a smaller-scale grid is used as the basic unit for division. It is more appropriate to use a 9-level grid to divide the subspace [20]. Positioning code of the component coordinate system in the subspace: the division origin is the identification point of the subspace in the floor subspace, and the direction of due east and north is the x, y axis, and the building growth direction is the z axis. In the subspace, the component is encoded in three-dimensional space to obtain the offset PQR in the three axis directions. The location code of the construction building code extended into the subspace is:

C_0 MN-F-M^' N^'-PQR (3)

In this coding system, C_0 *MN* is the building code for the global environmental positioning of the entire building; F is the height code for the height dimension positioning of entering the building; *M'N'* is the subspace of the entering floor in the second The floor subspace location code of the coordinates in the dimensional plane; PQR is the component location code in the subspace.

4 Overview of Beidou 3D Grid Position Coding

4.1 Code Generation Algorithm in Building Design Stage

This code is assigned to the component entity in the design stage of the building, and the fusion of multi-source data and the backtracking of information can be carried out based on the unique code in the subsequent stage [12].

In the BIM vertex coordinates, extract the minimum and maximum values of x, y, z coordinates to obtain the minimum component coordinates $S_{min}(X_{min}, Y_{min}, Z_{min})$ and maximum component coordinates $S_{max}(X_{max}, Y_{max}, Z_{max})$ to obtain the model range and calculate the approximate Space center point $S_0(X_0, Y_0, Z_0)$; $X_0 = (X_{min} - X_{max}/2)$; $Y_0 = (Y_{min} - Y_{max}/2)$; $Z_0 = (Z_{min} - Z_{max}/2)$.

If the latitude and longitude are expressed, directly according to the global floating point coordinate to the code conversion [21], if relative to the reference system, the following steps can be followed: determine the local coordinate system of the component in the BIM, determine the local coordinate system origin O, according to the orthogonal three Two of the two axes determine the direction of the coordinate system; determine the target coordinate system for transformation, according to the data in the BIM file, if the component is provided with the information of the reference space where it is located, the target coordinate system is the subspace coordinate system of the urban structure, if If only the reference space coordinate system of the floor is provided, the target coordinate system is the multi-storey coordinate system of urban buildings. After selecting the target coordinate system, determine the origin O' of the target coordinate system, and determine X', in the direction of true north and true east. X', Y' axis, get Z' axis; using the principle of coordinate transformation, the coordinate $S_0(X_0, Y_0, Z_0)$ of the component's center point in the component local coordinate system is transformed into the target coordinate system. First calculate the offset of the three axes of O' in the coordinate system $O(\Delta x, \Delta y, \Delta z)$, and then calculate the cosine of the included angle between the X' axis and the X axis, Y axis, and Z axis respectively $(\cos\alpha_1, \cos\beta_1, \cos\gamma_1)$ the cosine of the angle between Z^′ axis and X,Y,Z axis $(\cos\alpha_2, \cos\beta_2, \cos\gamma_2)$,the coordinates of the identification point of the entity in the building coordinate system can be obtained by the equation $T \cdot S' = S$, and the rotation matrix T can be expressed as:

$$T = \begin{bmatrix} \cos\alpha_2 & \cos\beta_2 & \cos\gamma_2 & 0 \\ \cos\beta_1\cos\gamma_2 - \cos\beta_2\cos\gamma_1 & \cos\alpha_2\cos\gamma_1 - \cos\alpha_1\cos\gamma_2 & \cos\alpha_1\cos\beta_2 - \cos\alpha_2\cos\beta_1 & 0 \\ \cos\alpha_1 & \cos\beta_1 & \cos\gamma_1 & 0 \\ x_0 & y_0 & z_0 & 1 \end{bmatrix}$$

After obtaining the identification points of the subspace and the longitude and latitude of the building (floor), the space identification [20] is generated according to the method of floating-point number transcoding, and this encoding becomes the unique spatial location identification of the component entity.

4.2 Multi-source Building Data Integration Algorithm Based on Coding Model

Many scenes in the building industry use spatial location to associate multi-source data, such as: file association management, automatic inspection, and intelligent construction [19]. Analyze the needs and feasibility of location identification codes in the integration of multi-source data; then design a large table of split index coded as RowKey, and on this basis, realize the efficient integration of multi-source data in the construction industry.

In order to realize the organization and management of multi-source information of structures, in addition to uniformly identifying global structure information, it is also necessary to establish a large index table with the code as the main key to associate data from different sources. MongoDB [11] was selected as the back-end database design because of its flexible design and high scalability; Nosql database can handle the problem of large differences in the types of entity attributes at different levels; MongoDB stores and manages according to the key-value pair format, and the code is used as the row key. The O(1) query efficiency of the Greek table, the row key is the building space identification code, and the attributes include the latitude and longitude information of the building and subspace where the component entity is located, and the number of floors.

In order to achieve multi-source data fusion based on spatial identification, the multi-source attribute information associated with the entity, such as design drawings, corresponds to the household registration information of the household. The index table also associates the link or file address of this information with the space identification code, so that the user can get the building code through the location of the component entity. Since the code of a certain building entity is unique in the entire data table, it can According to the code, locate the attribute dictionary of an entity in the database, and associate it with the multi-source data related to the spatial location.

4.3 Data Retrieval Algorithm Based on Coding Model

Take point query, range query and distance query based on building space constraints as examples to illustrate the data retrieval method.

Point Query. Point query refers to query all objects in the vicinity of a specified point [11]. The specific requirements in this research scenario are: when a fire occurs, the fire hydrant near the location of the firefighter. The nearby range here is limited to the same floor. As shown in Fig. 5 below, you want to query the objects near the location of the asterisk, which is the range of the dotted circle. This range includes three subspaces BCE.

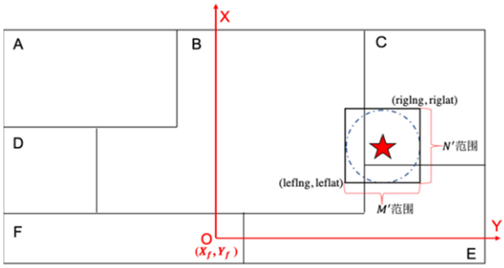

Fig. 5. KNN query of points in a certain floor.

>Use the code to calculate the range near the asterisk. The query on a certain floor may span multiple subspaces. Choose the floor coordinate system to divide the eighth level (distance from the equator 1 m). The query center coordinates can be latitude and longitude coordinates (x_0, y_0). The latitude and longitude of the southwest and northeast corners of the outer rectangle are letlat, letlng, riglat, riglng, respectively. The latitude and longitude points (x, y) in the outer rectangle of the floor coordinate system satisfy $x \geq (\text{letlat} - X_f)\ and\ y \geq (\text{letlng} - Y_f)\ and\ x \leq (\text{riglat} - X_f)\ and\ y \leq (\text{riglng} - Y_f)$. Here (x, y) means the distance from the origin in the local coordinate system, and the number of digits after the building code is the number of grids offset in the local coordinate system. The grid scale divided by the floor coordinate system is $1/32$, and the deviating longitude and latitude to the number of grids to the conversion multiple is $32 \times 60 \times 60$. Construct the complete structure of the building code $C_0MN\_UXXX\_M'N'$, the offset in the floor coordinate system is fixed $M'N'$ two bits. $M'N'$ is signed, and the conversion magnification is expressed as L, and the coding filter condition is

$$M\hat{\ }' \leq L(riglat\text{-}X\_f) \quad and\ M\hat{\ }' \geq L(leflat\text{-}X\_f) \tag{4}$$

$$N\hat{\ }' \leq L(riglng\text{-}Y\_f) \quad and\ N\hat{\ }' \geq L(leflng\text{-}Y\_f) \tag{5}$$

Range Query. Range query refers to query all objects within the framed range [11]. The specific requirements in this research scenario are: query all beams in a room, as shown in subspace C in Fig. 6; or delineate an arbitrary closed graphic to query all specific component entities contained in it, as shown in the figure below that spans three subspaces ABD Irregular shades of blue.

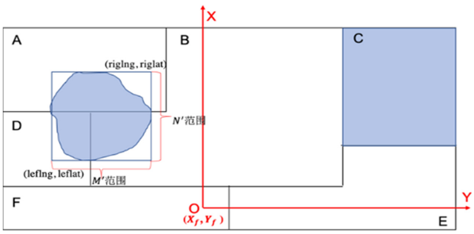

Fig. 6. Range query in a certain floor. (Color figure online)

Based on the outsourcing rectangle point search method, any closed graph is used as the query range. If the query range is a divided structure in a building, enter a latitude and longitude point $P(x, y)$ in the subspace, and request to return a component of the subspace where the point is located. Calculate the coordinates of P in the coordinate system $O(x_f, y_f)$ then divide by the degree to the span code to the conversion magnification L to obtain the offset code number M', N' of the point P. The subspace identification point C_0 where point P is located should be closer to point P, and the offset of C_0 in the floor coordinate system M_c, N_c should satisfy the following equation, and ϵ should be as small as possible, that is, as close as possible to a constant value: ${M_c}^2 + {N_c}^2 = M'^2 + N'^2 + \epsilon$. There is a situation where any point in the subspace reaches the identification point of the space and is farther from the identification point of other subspaces. This article takes the three closest coding values, and then finds the latitude and longitude of the subspace contour in the detailed attribute column of the corresponding data row String, to judge whether the point is in the polygon, and get the final constipation, you can use the matching algorithm to get all the specific component entity data rows whose subspace code is M_c, N_c.

Distance Query with Constraints. The query in the building must consider the structural characteristics of the building itself, such as the distance between the components A and B in the two rooms due to the barrier of the door, not a straight line distance, and there are multiple passable paths. Given a query point and multiple possible target points, the constrained distance query is to return the shortest distance from the query point to each target point.

The calculation of the shortest distance of multi-path can use "Dijkstra algorithm" [3], first determine the distance of each directly adjacent point. In this scenario, it may be the distance between the component in the subspace and the node of the subspace door, or the direct distance between two doors, which can be considered as the distance between the codes of two structures. Taking codes $C_0MN\_UXXX\_M_1'N_1'\_P_1Q_1R_1$ and $C_0MN\_UXXX\_M_2'N_2'\_P_2Q_2R_2$ as an example, the R code on the height dimension is not considered, and the two codes on the same floor differ only in subspace coding and fine coding. Taking the floor marking point as the reference point, the distance of code 1 in the direction of true east and true north of this point is $L_fM_1' + L_rP_1 \, and \, N_1' + L_rQ_1$, and the distance of code 2 in the direction of true east and true north of this point is $L_fM_2' + L_rP_2$ and $L_fN_2' + L_rQ_2$, then the distances between Code 1 and Code 2 in the direction of True East and True North are: $(L_fM_1' + L_rP_1) - (L_fM_2' + L_rP_2)$; $(L_fN_1' + L_rQ_1) - (L_fN_2' + L_rQ_2)$

The distance between latitude and longitude in the two directions can be converted into a plane distance according to the formula to obtain the plane distance between two nodes.

5 Experiment

Based on the self-designed building data visualization and management system, this section carries out typical application experiments such as code generation experiment, building multi-source data association and query from model establishment and application to verify the correctness, efficiency and feasibility of the coding model.

There are many types of BIM software in the construction industry, with different data formats. In this experiment, the Web terminal is selected for the display and function realization of the BIM model, and the geometric spatial data of the 3D model of the BIM platform such as Revit is analyzed and displayed on the Web terminal through WebGL. The background is connected to the database to manage and query the data information related to the construction and building. Interaction through the web.

Choose B/S web application framework verification, based on WebGL and HTML5 language, the framework level and function are shown in Fig. 7.

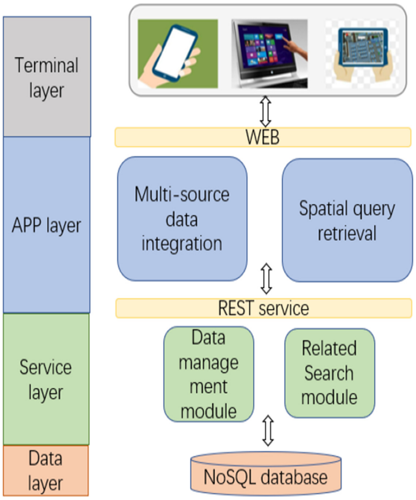

Fig. 7. Experimental framework structure function diagram.

Model Data Analysis and Model Reconstruction. The program parses the BIM data and obtains the absolute position coordinates of the building and subspace identification points, which lays the foundation for subsequent operations. The Revit Architecture building model file is converted into a JSON format file, and WebGL parses the JSON and visualizes it on the terminal. The exported building model must conform to the OBJ format, including four contents: material texture, geometric characteristics, custom metadata and object record object attribute data, which is associated with an entity through an identifier ID. After getting the parsed properties of each component, WebGL visualizes the model data on the Web. Figure 8 shows the hierarchical renderings of the subspace after model reconstruction and some attribute information of the corresponding modules. The results of the other levels are similar.

Fig. 8. Subspace after model reconstruction.

Coding Generation Experiment of Constructing Building Model. The analyzed subspace and building outline information associated with the component, as shown in Fig. 9, is the result of the experimental data encoding.

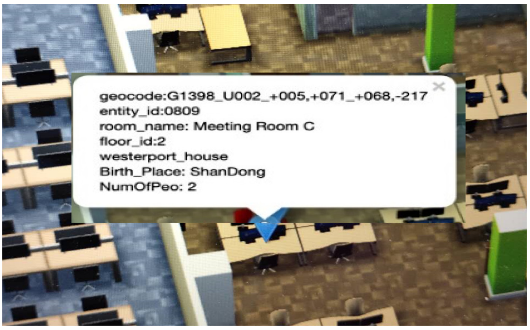

Fig. 9. Encoding result.

Multi-source Data Integration. According to the relationship between data, multiple data tables in the database can be associated to integrate multi-source data. After the association, the attribute information of the component also contains the corresponding multi-source information. The component data table is a key in the JSON dictionary based on the structure of the building code, while the value is composed of multiple attributes, realizing fast search based on key-value pairs. The experimental results, as shown in Fig. 10, enter the subspace and choose an entity to pop up the properties of the component itself and the multi-source properties of the associated subspace.

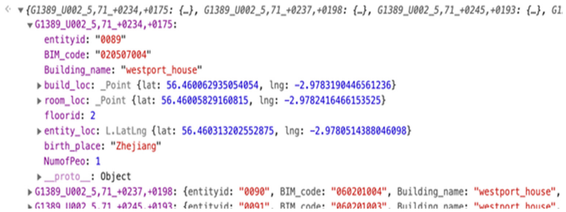

Fig. 10. Multi-source information integration display results.

Data Query and Retrieval Experiment Based on Coding Model

Point Query. Take the point query in the subspace as an example, the user selects the query point, the default query radius is 10 m, and the query result is shown in Fig. 11. The codes are constrained within the outsourcing rectangle, and the code key values are filtered to obtain a code set that meets the query conditions.

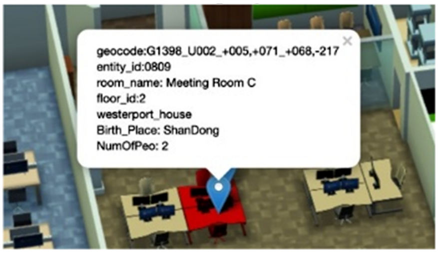

Fig. 11. Point query result.

Range Query. The user arbitrarily specifies a certain range to get all specific entities in it, which may be a certain floor or an irregular polygon that breaks through the existing boundary of the building, as shown in Fig. 12.

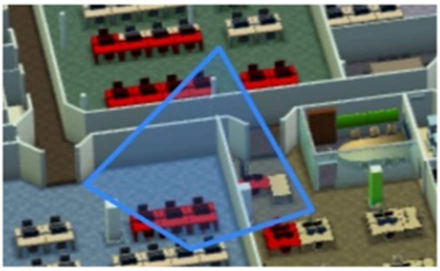

Fig. 12. Query across indoor boundary polygon range.

Coding Comparison. The accuracy of the range query based on the building code is high, especially when the query range is the inherent space division in the building, the accuracy is almost 100%; and the query efficiency is very high, only the matching code is required. The two-direction span code of the spatial coding can directly obtain the query result; this query requirement is more common in the building scene. The global rigid grid division ignores the boundaries of the object entity itself, such as the Beidou grid reference frame. Each division grid exists objectively, and the boundaries of these grids cannot fit the internal structure of the building. As shown in Fig. 13. In the query scenario, the query can only be performed based on the outsourced patch of the subspace. The range of the outsourcing patch is very different from the actual range of the subspace, resulting in a low accuracy rate, which will include many non-target entities; if a smaller grid with a larger level is used for aggregation, irregular polygons like the subspace are fitted It requires constant iterative calculations, and the amount of calculation is large and the efficiency is not high. Figure 14 shows a schematic diagram of the effect of global rigid grid division.

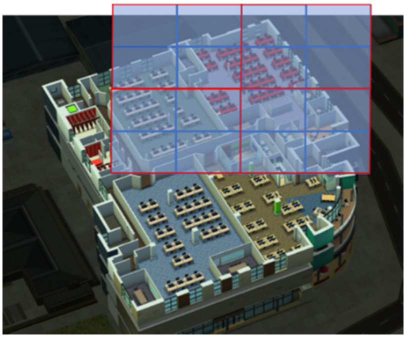

Fig. 13. Global rigid meshing result.

Fig. 14. Fine fill grid meshing result.

6 Summary and Outlook

Construction information management plays a huge role in the implementation of construction projects and the macro-management of the construction industry. It is not only the function of project management, but also the foundation of project management. The full play of IT technology in the construction field requires the standardization, standardization and unification of construction information, which is also the basic link of construction industry informatization.

However, the establishment of building space identification position coding is a systematic project. This article analyzes the framework of building space identification position coding and found that the existing rules are inconsistent and inefficient, and proposes a construction building coding based on the Beidou grid Rules, and the corresponding point query, range query, distance query and other algorithms to solve these problems. Many issues still need to be further studied: (1) Research on how to improve the location coding of building space identification, further increase accuracy, and improve the retrieval efficiency of components in a heterogeneous cross-database environment; (2) To achieve fine-grained buildings and their components In the computer programming environment, the automatic assembly of the component is completed by identifying the code of the connector at a specific position. (3) Most of the operations of spatial identification position coding are done manually. In the case of a small number of buildings in the initial application, the task requirements can be met, but when the number of components increases sharply, if the new data can be automatically added Carrying out the coding of the space identification position of the building and building and automatic warehousing can improve its efficiency.

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