

## **SPECIFICATION**

**Title of Invention:** METHOD, DEVICE, AND COMPUTER-READABLE RECORDING MEDIUM FOR CONFIGURING AND UTILIZING SPACE INFORMATION OF THREE-DIMENSIONAL MODELING DATA

### **Technical Field**

[1] The present disclosure relates to a technology for configuring space information for three-dimensional data, and more particularly, to a technology which is capable of accurately identifying attribute information of three-dimensional data, and the like by defining a method of configuring space information capable of defining, in geometry information of three-dimensional data, attribute information including an association relationship between respective objects, and the like, and enables the definition and utilization of space information in a quite easy method.

### **Background Art**

[2] Attribute information regarding each space and the like, including three-dimensional modeling data, are needed for the maintenance and management of buildings or facilities. In particular, recently, various types of data regarding the above-mentioned buildings or facilities have been used even for energy management, city control, fire and disaster response, and the like.

[3] From among these types of data, three-dimensional modeling data regarding each building or facility mentioned above is representatively used. Three-dimensional modeling data refers to all types of data that may implement a shape and the like of each object by a computing apparatus, including three-dimensional polygon data regarding a virtual object generated by design drawings, actual measurement, or the like.

[4] When such modeling data is used, general 3D modeling produced according to dimensions from drawings of buildings or facilities varies according to a 3D modeling format in addition to geometry information. However, in most cases, only hierarchical (layer) information, such as a name information collection of objects, layer elements, and autodesk FBX interchange file (FBX) format, may be inserted.

[5] Information of a format of modeling data stored in this way basically has

a limitation in not having additional attribute information of detailed modeling in addition to hierarchical information of modeling objects, according to geometry, texture, materials, and formats.

[6] As described above, because the meaning of spaces may not be known only with geometry information available in existing modeling data, a function of utilizing information by using attribute information (searching for space-to-space paths, objects in a space, and the like) may not be applied, and thus, data, such as energy management, city control, and prediction of fire and disaster damage, may not be utilized.

[7] A method of storing attribute information of various types of spaces in three-dimensional modeling data has been used to improve the shortcomings described above. For example, Patent Application No. 10-2013-0027695 and the like provide a technology for combining and managing indoor space data in a standard space information format (e.g., indoorGML) with three-dimensional modeling data.

[8] However, in the case of such an existing standard space information format, when space information is specified according to the original purpose for which each format is used, a data structure may become significantly complicated, the capacity thereof may also increase, an amount of data may not be reduced, space information may not be inserted, and accordingly, the space information may not be used for the general purpose.

### **Description of Embodiments**

#### **Technical Problem**

[9] Accordingly, the present disclosure is derived to solve the above problems, and provides a technology that enables general-purpose utilization of three-dimensional modeling data by presenting a new space information configuration structure enabling a quite easy configuration of lightweight space information when configuring space information in three-dimensional modeling data, compared to existing technologies.

#### **Solution to Problem**

[10] In order to achieve the above object, a method of configuring and utilizing space information of three-dimensional modeling data, implemented by

a computing apparatus including one or more processors and one or more memories storing instructions executable by the processors, according to an embodiment of the present disclosure, may include: a first space information configuration operation of, when receiving, as data input from the outside, modeling data capable of defining an external shape of an object through three-dimensional modeling regarding an object, configuring, in modeling data, first space information for defining a shape of a space constituted by at least one object on the basis of a modeling form; a connection information configuration operation of configuring connection information including link data that is a connection relationship between respective pieces of node data by using input data related to a connection relationship for each piece of node data received from the outside; a second space information configuration operation of configuring, by using attribute information regarding each object input from the outside, second space information for defining attribute information of a space constituted by objects; and a space information configuration completion operation of configuring space information regarding each space and modeling data of each object included in the space by interlinking, with respect to each space, space information including the first space information, the second space information, and the connection information.

[11] The first space formation defined in the first space information configuration operation may include at least one of first detailed information for defining a shape of each space as lightweight data, second detailed information that is information capable of distinguishing whether each space relates to an outdoor space or an indoor space, and third detailed information that is information for classifying a type of a space constituted by an object on the basis of a modeling form.

[12] The first space information configuration operation may include: a frame generation operation of, when receiving the modeling data, generating lightweight frame data capable of defining an external shape of each space on the basis of the modeling data; a zone configuration operation of configuring, for each frame data, a zone of a space by using geometry information drawn by using a floor surface of the space constituted by objects; and a height definition operation of

defining a height of the space by using modeling data of objects when the space constituted by the objects is an indoor space.

[13] The node data may be defined through the modeling data, for example, a center of a floor surface of a space constituted by objects may be defined as node data of a space constituted by an object and the object when an object is an object constituting an external shape and internal space of a building, a center of each object may be defined as node data of an object when an object is an object connecting respective spaces to each other, and an intersection point of link data connecting respective pieces of node data to each other may be defined as pieces of node data regarding a path space connecting spaces to each other.

[14] The second space information may include at least one of a name of a space, a use purpose of the space, a type of space, geometry information of a shape constituting the space, indoor or outdoor distinguishment information of the space, drawing information of the space, and detailed architectural information about the space.

[15] The space information configuration completion operation may include, when pieces of data for configuration of space information received from the outside include singular object data that is information regarding a singular object within each space, automatically configuring, as space information regarding the singular object data, space information regarding a space to which the singular object data belongs.

[16] The method may further include, after performing the space information configuration completion operation, a space information utilization operation of generating event prediction data that is data obtained by predicting, by using the space information, an effect when an event affecting a space occurs.

[17] The space information utilization operation may include generating, as the event prediction data, objects affected by the event as objects within a space when the event occurs, a range of an influence between respective objects, a diffusion path of a situation that may occur when the event occurs through a topological relationship of node data, and a quantitative numerical value for an influence received by each space according to the event on the basis of attribute information regarding an object included in the space.

[18] An apparatus for configuring and utilizing space information of three-dimensional modeling data, implemented by a computing apparatus including one or more processors and one or more memories storing instructions executable by the processors, according to an embodiment of the present disclosure, may include: a first space information configuration unit that, when receiving, as data input from the outside, modeling data capable of defining an external shape of an object through three-dimensional modeling regarding the object, configuring, in the modeling data, first space information for defining a shape of space constituted by at least one object on the basis of a modeling form; a connection information configuration unit that configures node data corresponding to a space-specific center point by using the first space information, and configures connection information including link data that is a connection relationship between respective pieces of node data by using input data related to a connection relationship for each piece of node data received from the outside; a second space information configuration unit that configures, by using attribute information regarding each object input from the outside, second space information for defining attribute information of a space constituted by objects; and a space information configuration completion unit that configures space information regarding each space and modeling data of each object included in the space by interlinking, with respect to each space, space information including the first space information, the second space information, and the connection information.

#### **Advantageous Effects of Disclosure**

[19] According to the present disclosure, when configuring space information on the basis of information input from the outside such as a management terminal, space information regarding all indoor and outdoor spaces may be defined, on the basis of attribute information for identifying a space constituted by each object, by defining node data for designating each space and link data for defining a connection relationship between respective spaces.

[20] In other words, space information may be configured quite easily and accurately through attribute information of a space constituted by objects, and data defined by nodes and links, rather than complex data, thereby enabling quite

easy configuration of lightweight space information, compared to existing technologies.

[21] Accordingly, modeling data and space information may be used for energy management, city control, fire and disaster response, and the like, thereby enabling general purpose utilization of space information.

### **Brief Description of Drawings**

[22] FIGS. 1 to 3 are flowcharts of a method of configuring and utilizing space information of three-dimensional modeling data, according to an embodiment of the present disclosure.

[23] FIG. 4 is a block diagram of an apparatus for configuring and utilizing space information of three-dimensional modeling data, according to an embodiment of the present disclosure.

[24] FIG. 5 is a diagram illustrating an example in which space information is generated according to an implementation of an embodiment of the present disclosure.

[25] FIGS. 6 to 8 are views illustrating an example in which each space, nodes, and link data are configured according to an implementation of an embodiment of the present disclosure.

[26] FIG. 9 is an example of an internal structure of a computing apparatus according to an embodiment of the present disclosure.

### **Best Mode**

[27] Hereinafter, various embodiments and/or aspects will be disclosed with reference to the drawings. In the description below, for the purposes of description, numerous specific details are set forth to provide a thorough understanding of one or more aspects. However, it will also be recognized by one of ordinary skill in the art that such aspect(s) may be practiced without these specific details. The following description and accompanying drawings set forth in detail certain illustrative aspects of one or more aspects. These aspects are illustrative, however, and some of various methods in principles of various aspects may be employed, and the descriptions set forth are intended to include all such aspects and their equivalents.

[28] As used herein, “embodiment”, “example”, “aspect”, “illustration”, and

the like may not be construed as being advantageous or having an advantage in any aspect or design described herein over other aspects or designs.

[29] It will be further understood that the terms "comprise or include" and/or "comprising or including" specify the presence of stated features and/or elements, but do not preclude the presence or addition of one or more other features, elements, and/or groups thereof.

[30] Also, although the terms first, second, etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another element. For example, a first element could be termed a second element, and similarly, the second element could also be termed the first element, without departing from the scope of the present disclosure. The term "and/or" includes any and all combinations of a plurality of associated listed items.

[31] In addition, in the embodiments of the present disclosure, unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the present disclosure belongs. Terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[32] FIGS. 1 to 3 are flowcharts of a method for configuring and utilizing space information of three-dimensional modeling data, according to an embodiment of the present disclosure. FIG. 4 is block diagram of an apparatus for configuring and utilizing space information of three-dimensional modeling data, according to an embodiment of the present disclosure. FIG. 5 is a diagram illustrating an example in which space information is generated according to an implementation of an embodiment of the present disclosure. FIGS. 6 to 8 are views illustrating examples in which each space, nodes, and link data are configured according to an implementation of an embodiment of the present disclosure.

[33] Before describing with reference to the drawings described above, it is

understood that a method of configuring and utilizing space information of three-dimensional modeling data according to an embodiment of the present disclosure is performed by a computing apparatus that will be described later with reference to FIG. 9. In the present disclosure, the computing apparatus will be understood as a concept including all terminals capable of processing, storing, managing, outputting, and inputting data, such as personal computers, server terminals, database management terminals, portable computers, notebook computers, smart pads, and smart phones.

[34] Also, the computing apparatus may have the same structure as an apparatus 10 for configuring and utilizing space information of three-dimensional modeling data, according to an embodiment of the present disclosure, as shown in FIG. 4, or may be constituted as a terminal having an inclusion relationship with the corresponding structure.

[35] In addition, the computing apparatus may refer to a functional apparatus that is the same as a plurality of terminals capable of using three-dimensional modeling data and space information by implementing a method of configuring and utilizing space information of three-dimensional modeling data, according to an embodiment of the present disclosure, or is included in a corresponding structure.

[36] On the basis of the above description, referring to FIG. 1, in a method of configuring and utilizing space information of three-dimensional modeling data, according to an embodiment of the present disclosure, a computing apparatus performs a first space information configuration operation S10 of configuring, in modeling data, first space information for defining a shape of space constituted by at least one object on the basis of a modeling form when receiving, as data input from the outside, the modeling data capable of defining an external shape of an object through three-dimensional modeling regarding the object.

[37] In the present disclosure, the input of data from the outside indicates that data for performing functions of the present disclosure is input from external terminals that may be connected, via a network or hardware, with a computing apparatus to transmit and receive data via wired and wireless network lines, such as a terminal for generating and/or managing three-dimensional modeling data

as described above or a terminal (e.g., a manager (user) terminal) capable of inputting space information.

[38] In the present disclosure, objects refer to units constituting an indoor or outdoor space. For example, objects may include units constituting a certain space, such as an indoor wall, a ceiling, a door, a window, and an outdoor building wall, and facilities. Three-dimensional modeling regarding an object may include data generated, via a computing apparatus, on the basis of a drawing of an object or a numerical value and/or visual data (e.g., a captured image, video, and the like) of actual measurements of an object, for example, polygon data expressing the object in three dimensions and the like.

[39] In the present disclosure, a target including the above-described object for which three-dimensional space information is configured refers to any space that may be implemented in three dimensions, and is not limited to any space object that may be created via a modeling technique. Three-dimensional space information may be produced through a three-dimensional modeling tool on the basis of a design drawing of an actually present target (space) (drawing information used for an architectural design, such as a plan view, an elevation view, a cross-sectional view, or the like). As needed, additional information may be collected through on-site inspections. In other words, modeling data may be produced through drawings, but data provided by scanning or actual measurement may be corrected and used.

[40] In operation S10, when receiving the above-described modeling data, on the basis of a modeling form that may be identified via the corresponding modeling data, first space information for defining a shape of space constituted by at least one object are defined with respect to a space or an object included in the space, and is configured in the modeling data.

[41] Here, various types of detailed information for defining a shape of space, as described above, may be defined in the first space information defined in operation S10. For example, the first space information may include at least one of: first detailed information for defining a shape of each space as lightweight data, second detailed information that is information for distinguishing whether each space relates to an outdoor space or an indoor space, and third detailed

information that is information for classifying a type of space constituted by an object on the basis of a modeling form of each object.

[42] For example, a shape of a space may be defined in three-dimensions or two-dimensions by using only an outer boundary line of the space that is defined due to a space constitution by an object, rather than detailed modeling data of the object. In other words, the first detailed information may be defined as, for example, information about a boundary of a space constituted by objects as an external shape thereof is defined by the objects.

[43] The second detailed information may be defined as follows. Defining the second detailed information is easily misunderstood as a method of authoring only indoor space information, but is not only for modeling information based on indoor/outdoor, and a modeling form is used as described above, and thus, any second detailed information having a conceptual attribute for distinguishing indoor/outdoor may be used without indoor/outdoor distinction. The second detailed information described above may be configured through a drawing or by an input from the outside.

[44] The third detailed information refers to information for classifying a type of space constituted by an object on the basis of a modeling form, such as a room, a bathroom, an elevator, a door, or a passage. For example, a door may be classified as a door by a shape thereof, a portion, which has a shape close to a square or other shapes and is surrounded by a wall, may be classified as a room, a portion, which is connected to a plurality of doors and has a long shape or a branching shape, may be classified as a passage or the like.

[45] In other words, when defining the first to third detailed information in the performance of operation S10, a shape of a space is extracted on the basis of a floor surface through objects capable of distinguishing a wall and floor, a floor surface, and a ceiling via modeling information. In this case, the distinguishment of a wall is significant, and a shape of a space is extracted on the basis of a center line of the wall or by distinguishing inner and outer walls of the wall. For example, a closed shape constituted by a wall may be recognized as an indoor space such as a room, as described above, and may express the interior of a building.

[46] The first to third detailed information for classifying space information

regarding each space or defining the same as lightweight data may be defined according to a detailed process as shown in FIG. 2.

[47] Referring to FIG. 2, in the performance of operation S10, when receiving modeling data, the computing apparatus performs frame generation operation S11 of generating lightweight frame data capable of defining an external shape of each space on the basis of the modeling data. Referring to FIGS. 5 to 8 and the like, in the present disclosure, when receiving modeling data, first space information is configured by editing content on the basis of the received modeling data.

[48] First, frame data is generated by using, as a basic mode, a drawing method of modeling or drawing a drawing on the basis of modeling and drawing an approximate external shape thereof on the basis of a drawing. Here, objects 121, 122, and 123, external shapes 111 and 112 of a space, and a boundary line 114 defining the external shapes of the space, and the like, shown in FIGS. 5 to 8, may be defined as frame data.

[49] Thereafter, the computing apparatus performs zone configuration operation S12 of configuring, for each frame data, a zone of the space by using geometry information drawn by using a floor surface of the space constituted by objects. When defining data regarding an indoor space and an outdoor space, each space may have a floor surface as a lowermost boundary determined. Therefore, when shape geometry information of detailed space information is needed to configure a zone of a space in frame data on the basis of the drawing, a space may be expressed from the frame data in a drawing method. Otherwise, the space may be defined as a conceptual space using quite simple and lightweight data, such as a square or a circle.

[50] Here, the drawing is the basis, and thus, each zone of the space may be determined through geometry information drawn through a floor surface. Referring to FIG. 7, inside the boundary line 114 indicating each building space, spaces for particular purposes (e.g., a lobby, a common space, and the like) 113 and 116 rather than a room defined in a circle, are defined in a rectangle, and a space 115 referring to a room, a space 102 referring to a passage, and the like are configured as zones of the space in operation S12.

[51] Thereafter, when the space constituted by the objects is an indoor space, height definition operation S13 of defining a height of the space by using the modeling data of the objects is performed. For example, a height in a three-dimensional space is distinguished by applying a shape protruding from the floor to the ceiling on the basis of a height of an indoor floor. When an outdoor space needs only a concept of a space and thus is a concept such as a garden, the outdoor space does not need to be derived, but a height thereof may be designated.

[52] After performing operation S10 defined as described above, the computing apparatus performs connection information configuration operation S20 of configuring node data corresponding to a space-specific center point by using the defined first space information, and configuring connection information including link data that is a connection relationship between respective pieces of node data by using input data related to a connection relationship for each node data received from the outside.

[53] In the present disclosure, node data may be data for representing each space or objects constituting a space, precisely, centers of objects that need to be defined separately from the space, from among the objects, and link data may be data for expressing a connection relationship between respective pieces of node data. In other words, the link data is data for expressing each space, an influence and connection between the spaces, and the like by using quite lightweight data.

[54] A detailed example will be described with reference to FIGS. 6 to 8, and node data 131 is defined through modeling data. When an object is an object constituting an external shape and internal space of a building, a center of a floor surface of a corresponding space, such as a room as a space constituted by objects, is defined as node data of a space constituted by an object and the object.

[55] Meanwhile, when an object is an object (door) connecting respective spaces to each other, a center of each object is defined as node data of the object, and an intersection point 131-1 of pieces of link data 130 and 130-1 connecting respective pieces of node data to each other is defined as pieces of node data regarding a path space connecting spaces to each other.

[56] In other words, connection points of nodes and links may be found on modeling on the basis of a door or a passable entrance element, a center point of a space constituted in this way may be generated as a reference point of a node, and nodes of each space and a significant object may be constituted through a center of an indoor space and a center of a door.

[57] As defined in this way, an association relationship between a space and a space may be conveniently identified through node and link data. Here, only when nodes are arranged in a space, association and topological relationships may be identified, and information needs to be separately identified with respect to a space in which nodes are not arranged. Also, through the link data, data information may be managed so that node data connected by each piece of link data may be retrieved.

[58] After performing operations S20 and S10, the computing apparatus performs second space information configuration operation S30 of defining more detailed attribute information regarding each space, i.e., configuring second space information for defining attribute information of a space constituted by objects by using attribute information regarding each object input from the outside.

[59] In the present disclosure, the second space information may be a concept defining detailed attributes of a space, for example, may include at least one of a name of a space, a use purpose of the space, a type of space, geometry information of a shape constituting the space, and indoor or outdoor distinguishment information of the space, drawing information of the space, and detailed architectural information regarding the space.

[60] As needed, modeling information corresponding to a space and detailed architectural information, such as building information modeling (BIM), may be used. However, the BIM may have a quite large capacity and be complex, may have features that are incompatible with the objectives of the present disclosure, and may be configured to be selectively used when all or part of information included in the BIM or the like are input from the outside.

[61] When the performance of operations S10 to S30 is completed, the computing apparatus performs space information configuration completion operation S40 of configuring space information regarding each space and

modeling data of each object included in the space by interlinking, with respect to each space, space information including the first space information, the connection information, the second space information, and the like collected by the above-described functions.

[62] In other words, as shown in FIG. 5, in operation S10, space information 110 regarding each space and space information 120 regarding a singular object are configured according to examples of deriving first space information and connection information from pieces of three-dimensional modeling data 100 through modeling data 101 regarding an object, configuring second space information through data 200 input from external terminals 20, and the like.

[63] According to the processes described above, when configuring space information on the basis of information input from the outside, such as the manager terminals, space information regarding all indoor and outdoor spaces may be defined through definitions of node data designating each space and link data defining a connection relationship between respective spaces, on the basis of attribute information for identifying a space constituted by each object.

[64] In other words, space information may be configured quite easily and accurately through attribute information of a space constitute by objects, and data defined by nodes and links, rather than complex data, and thus, lightweight space information may be quite easily configured, compared to existing technologies.

[65] Meanwhile, configuring separate space information 120 regarding a singular object in the above description is mentioned in the description of FIG. 5. In the present disclosure, such a singular object is defined as a singular object such as a point of interest (POI). In the performance of operation S40, when pieces of data for configuration of space information received from the outside include singular object data that is information regarding a singular object within each space, the computing apparatus automatically configures, as space information regarding the singular object data, space information regarding a space to which the singular object data belongs.

[66] Such a singular object is an object corresponding to 123 in FIGS. 6 to 8, and is separately usable location information that may be used even when not belonging to a space. However, a POI arranged within a space is regarded as a

POI affecting the space. For example, the singular object is a singular object that shows a connection location and attributes of equipment representing a sensor or an event and belongs to a particular space. When a space is in an association relationship with another space by a node or a link, the other space associated with a POI may be retrieved via the POI, and the POI of the other space may also be retrieved.

[67] When performing operation S40 as described above, each space information, node data, and link data may be configured, for management thereof, to respectively have pieces of non-overlapping and unique identification (ID) information. For example, even when one room is constituted in the form of modeling and the room is divided into several spaces, the spaces may not have overlapping IDs and thus, need to be divided separately.

[68] As described above, after space information regarding an object, such as each space or a singular object, is configured, various types of external terminals may use the same for various purposes. In other words, after operation S40 is performed, the computing apparatus may perform space information utilization operation S50 of generating event prediction data, which is data obtained by predicting an effect when an event affecting a space occurs, by using space information according to a request from the outside.

[69] Here, the event prediction data generated in operation S50 may include, for example, objects affected by the event as objects within a space when the event occurs, a range of an influence between the respective objects, a diffusion path of a situation that may occur when the event occurs through a topological relationship of node data, a quantitative numerical value of an influence received by each space according to the event on the basis of attribute information regarding an object included in the space, and the like.

[70] As described above, as data, which is quite lightweight and is optimized for event prediction and the like, is managed as space information, modeling data and space information are utilized for energy management, city control, fire and disaster responses, and the like, thereby enabling general-purpose utilization of space information.

[71] FIG. 4 is a block diagram of an apparatus 10 for configuring and utilizing

space information of three-dimensional modeling data, according to an embodiment of the present disclosure. In the following description, descriptions of unneeded portions overlapping all of the above descriptions will be omitted.

[72] Referring to FIG. 4, the apparatus 10 (hereinafter referred to as an apparatus of the present disclosure) for configuring and utilizing space information of three-dimensional modeling data, according to an embodiment of the present disclosure includes a first space information configuration unit 11, a connection information configuration unit 12, a second space information configuration unit 13, and a space information configuration completion unit 14.

[73] Meanwhile, in the present disclosure, data received from the outside and data needed for performing each function of the present disclosure or generated and managed through the same may be stored and managed in a memory provided in a structure for managing each data, or in a separate database 30.

[74] When receiving, as data input from the outside 20, modeling data capable of defining an external shape of an object through three-dimensional modeling regarding the object, the first space information configuration unit 11 performs a function of configuring, in the modeling data on the basis of a modeling form, first space information for defining a shape of a space constituted by at least one object. In other words, in the above description, the first space information configuration unit 11 will be understood as a component that performs all functions performed by the computing apparatus mentioned in the descriptions of operations S10 and S11 to S13.

[75] The connection information configuration unit 12 performs a function of configuring node data corresponding to a space-specific center point by using the first space information, and configuring connection information including link data, which is a connection relationship between respective pieces of node data, by using input data related to a connection relationship between respective pieces of node data received from the outside. In other words, in the above description, the connection information configuration unit 12 will be understood as a component that performs all functions performed by the computing apparatus mentioned in the description of operation S20.

[76] The second space information configuration unit 13 performs a function

of configuring second space information for defining attribute information of a space constituted by objects by using attribute information regarding each object input from the outside 20. In other words, in the above description, the second space information configuration unit 13 will be understood as a component that performs all functions performed by the computing apparatus mentioned in the description of operation S30.

[77] The space information configuration completion unit 14 performs a function of configuring space information regarding each space and modeling data of each object included in the space by interlinking, with respect to each space, space information including the first space information, the second space information, and the connection information. In other words, in the above description, the space information configuration completion unit 14 will be understood as a component that performs all functions performed by the computing apparatus mentioned in the description of operation S40.

[78] Meanwhile, as an element for performing all functions performed by the computing apparatus mentioned in the description of operation S50 in the above description, a space information utilization unit (not shown) may be additionally included in the apparatus 10 of the present disclosure.

[79] FIG. 9 shows an example of an internal structure of a computing apparatus according to an embodiment of the present disclosure, and in the following description, an unneeded description of an embodiment overlapping the descriptions of FIGS. 1 to 8 is omitted.

[80] As shown in FIG. 9, a computing apparatus 10000 may at least include at least one processor 11000, a memory 11200, a peripheral interface 11300, an input/output (I/O) subsystem 11400, a power circuit 11500, and a communication circuit 11600. Here, the computing apparatus 10000 may correspond to a user terminal A connected to a tactile interface device or the computing apparatus B described above.

[81] The memory 11200 may include, for example, a high-speed random access memory, a magnetic disk, SRAM, DRAM, ROM, a flash memory, or a non-volatile memory. The memory 11200 may include a software module, an instruction set, or other various types of data, which is needed for operation of

the computing apparatus 10000.

[82] Here, access to the memory 11200 from other components, such as the processor 11100 or the peripheral interface 11300, may be controlled by the processor 11100.

[83] The peripheral interface 11300 may couple input and/or output peripheral devices of the computing apparatus 10000 to processor 11100 and the memory 11200. The processor 11100 may perform various functions for the computing apparatus 10000 and process data by executing the software module or the instruction set stored in the memory 11200.

[84] The input/output subsystem 11400 may couple various types of input/output peripheral devices to the peripheral interface 11300. For example, the input/output subsystem 11400 may include a controller for coupling, to the peripheral interface 11300, peripheral devices, such as a monitor, a keyboard, a mouse, or a printer, or a touch screen or sensor as needed. According to another aspect, the input/output peripheral devices may be coupled to the peripheral interface 11300 without going through the input/output subsystem 11400.

[85] The power circuit 11500 may supply power to all or some of components of a terminal. For example, the power circuit 11500 may include a power management system, one or more power sources such as batteries or alternating current (AC), a charging system, a power failure detection circuit, a power converter or inverter, a power status indicator, or any other components for generating, managing, and distributing power.

[86] The communication circuit 11600 may enable communication with another computing apparatus by using at least one external port.

[87] Alternatively, as described above, as needed, the communication circuit 11600 may include an RF circuit to transmit and receive an RF signal, also known as an electromagnetic signal, to enable communication with another computing apparatus.

[88] The embodiment of FIG. 9 described above is only an example of the computing apparatus 10000, and the computing apparatus 10000 may have a structure or arrangement in which some components shown in FIG. 9 are omitted, additional components not shown in FIG. 9 are further included, or two or more

components are coupled to one another. For example, a computing apparatus for a communication terminal in a mobile environment may further include a touch screen or a sensor in addition to the components shown in FIG. 9, and the communication circuit 11600 may include a circuit for RF communication of various communication methods (WiFi, 3G, LTE, Bluetooth, NFC, Zigbee, and the like). Components that may be included in the computing apparatus 10000 may be implemented in hardware including an integrated circuit specialized for processing of one or more signals, or applications, in software, or in a combination of both hardware and software.

[89] The methods according to embodiments of the present disclosure may be implemented in the form of program instructions that may be executed through various types of computing apparatus, and may be recorded in a computer-readable medium. In particular, a program according to the present embodiment may be configured as a PC-based program or an application dedicated to a mobile terminal. An application to which the present disclosure is applied may be installed in a user terminal through a file provided by a file distribution system. For example, the file distribution system may include a file transmitter (not shown) that transmits the file according to a request of the user terminal.

[90] The apparatus described above may be implemented as a hardware component, a software component, and/or a combination of the hardware component and the software component. For example, the apparatuses and components described in the embodiments may be implemented by using one or more general-purpose or special-purpose computers, for example, such as a processor, a controller, an arithmetic logic unit (ALU), a digital signal processor, a microcomputer, a field programmable gate array (FPGA), a programmable logic unit (PLU), a microprocessor, or any other apparatuses capable of executing and responding to instructions. A processing apparatus may execute an operating system (OS) and one or more software applications executed on the operating system. The processing apparatus may also access, store, manipulate, process, and generate data in response to the execution of software. For convenience of understanding, although one processing apparatus is sometimes described as being used, one of ordinary skill in the art may understand that the processing

apparatus may include a plurality of processing elements and/or a plurality of types of processing elements. For example, the processing apparatus may include a plurality of processors, or one processor and one controller. Other processing configurations, such as parallel processors, are also possible.

[91] Software may include a computer program, code, instructions, or a combination of one or more thereof, and may configure a processing apparatus to operate as desired, or independently or collectively instruct the processing apparatus. The software and/or data may be permanently or temporarily embodied on any type of machine, component, physical apparatus, virtual equipment, computer storage medium, or apparatus to be interpreted by the processing apparatus or to provide instructions or data to the processing apparatus. The software may be distributed over networked computing apparatuses, and may be stored or executed in a distributed manner. The software and data may be stored in one or more computer-readable recording media.

[92] The method according to the embodiments may be implemented in the form of program instructions that may be executed through various types of computer means and recorded in a computer-readable medium. The computer-readable medium may include program instructions, data files, data structures, and the like alone or in combination. The program instructions recorded on the medium may be specially designed and configured for the embodiments, or may be known and available to one of ordinary skill in the art of computer software. Examples of the computer-readable recording medium include magnetic media such as hard disks, floppy disks, and magnetic tapes, optical media such as CD-ROMs and DVDs, magneto-optical media such as floptical disks, and hardware devices specially configured to store and execute program instructions, such as ROM, RAM, and flash memory. Examples of the program instructions include not only machine language codes, such as those generated by a compiler, but also high-level language codes that may be executed by a computer by using an interpreter or the like. The hardware devices described above may be configured to operate as one or more software modules to perform the operations of the embodiments, and the opposite case is also the same.

[93] As described above, although the embodiments have been described with reference to the limited embodiments and drawings, various modifications and variations may be made from the above description by one of ordinary skill in the art. For example, the described techniques are performed in a different order than the described method, and/or the described components of the system, structure, apparatus, circuit, and the like are coupled or combined to one another in a different form than the described method, or even when replaced or substituted by other components or equivalents, an appropriate result may be achieved. Therefore, other implementations, other embodiments, and equivalents to claims are also within the scope of the following claims.

## Claims

1. A method of configuring and utilizing space information of three-dimensional modeling data, implemented by a computing apparatus comprising one or more processors and one or more memories storing instructions executable by the processors, the method comprising:

a first space information configuration operation of, when receiving, as data input from the outside, modeling data capable of defining an external shape of an object through three-dimensional modeling regarding the object, configuring, in the modeling data, first space information for defining a shape of a space constituted by at least one object on the basis of a modeling form;

a connection information configuration operation of configuring node data corresponding to a space-specific center point by using the first space information, and configuring connection information including link data, which is a connection relationship between respective pieces of node data, by using input data related to a connection relationship regarding each piece of node data received from the outside;

a second space information configuration operation of configuring second space information for defining attribute information of a space constituted by the objects by using attribute information regarding each object input from the outside; and

a space information configuration completion operation of configuring space information regarding each space and modeling data of each object included in the space by interlinking, with respect to each space, space information including the first space information, the second space information, and the connection information.

2. The method of claim 1, wherein the first space information defined in the first space information configuration operation includes at least one of: first detailed information for defining a shape of each space as lightweight data; second detailed information that is information for distinguishing whether each space relates to an outdoor space or an indoor space; and third detailed information that is information for classifying a type of space constituted by an

object on the basis of a modeling form of each object.

3. The method of claim 2, wherein the first space information configuration operation includes:

a frame generation operation of, when receiving the modeling data, generating lightweight frame data capable of defining an external shape of each space on the basis of the modeling data;

a zone configuration operation of configuring, for each frame data, a zone of a space by using geometry information drawn by using a floor surface of a space constituted by objects; and

a height definition operation of defining a height of a space by using modeling data of an object when a space constituted by objects is an indoor space.

4. The method of claim 1, wherein the node data is defined through the modeling data, wherein, when an object is an object constituting an external shape and inner space of a building, a center of a floor surface of a space constituted by objects is defined as node data regarding a space constituted by an object and the object, when an object is an object connecting respective spaces to each other, a center of each object is defined as node data, and an intersection point of link data connecting respective pieces of the node data is defined as node data regarding a path space connecting spaces to each other.

5. The method of claim 1, wherein the second space information includes at least one of a name of a space, a use purpose of the space, a type of space, geometry information of a shape constituting the space, indoor or outdoor distinguishment information of the space, drawing information of the space, and detailed architectural information regarding the space.

6. The method of claim 1, wherein the space information configuration completion operation includes, when pieces of data for configuration of space information received from the outside includes singular object data that is

information regarding a singular object within each space, automatically configuring, as space information regarding the singular object data, space information regarding a space to which the singular object data belongs.

7. The method of claim 1, further comprising, after performing the space information configuration completion operation, a space information utilization operation of generating, by using the space information, event prediction data that is data obtained by predicting an effect when an event affecting a space occurs.

8. The method of claim 7, wherein the space information utilization operation comprises generating, as the event prediction data, objects affected by the event as objects within a space when the event occurs, a range of an influence between respective objects, a diffusion path of a situation that may occur when the event occurs through a topological relationship of node data, and a quantitative numerical value for an influence received by each space according to the event on the basis of attribute information regarding an object included in the space.

9. An apparatus for configuring and utilizing space information of three-dimensional modeling data, implemented by a computing apparatus comprising one or more processors and one or more memories storing instructions executable by the processors, the apparatus comprising:

a first space information configuration unit configured to, when receiving, as data input from the outside, modeling data capable of defining an external shape of an object through three-dimensional modeling regarding the object, configuring, in the modeling data, first space information for defining a shape of a space constituted by at least one object on the basis of a modeling form;

a connection information configuration unit configured to configure node data corresponding to a space-specific center point by using the first space information, and configure connection information including link data, which is a connection

relationship between respective pieces of node data, by using input data related to a connection relationship for each piece of node data received from the outside;

a second space information configuration unit configured to configure second space information for defining attribute information of a space constituted by objects, by using attribute information regarding each object input from the outside; and

a space information configuration completion unit configured to configure space information regarding each space and modeling data of each object included in the space by interlinking, with respect to each space, space information including the first space information, the second space information, and the connection information.

10. A computer-readable recording medium, wherein the computer-readable recording medium stores instructions allowing a computing apparatus to perform operations below, and the operations comprises:

a first space information configuration operation of, when receiving, as data input from the outside, modeling data capable of defining an external shape of an object through three-dimensional modeling regarding the object, configuring, in the modeling data, first space information for defining a shape of a space constituted by at least one object on the basis of a modeling form;

a connection information configuration operation of configuring node data corresponding to a space-specific center point by using the first space information, and configuring connection information including link data, which is a connection relationship between respective pieces of node data, by using input data related to a connection relationship for each piece of the node data received from the outside;

a second space information configuration operation of configuring second space information for defining attribute information of a space constituted by objects, by using attribute information regarding each object input from the outside; and

a space information configuration completion operation of configuring space

information regarding each space and modeling data of each object included in the space by interlinking, with respect to each space, space information including the first space information, the second space information, and the connection information.