

SHADE INFLUENCE AMOUNT EVALUATION SYSTEM, SHADE INFLUENCE AMOUNT EVALUATION METHOD, AND SHADE CALCULATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a shade influence amount evaluation system, a shade influence amount evaluation method, and a shade calculation system. The present invention particularly relates to a shade influence amount evaluation system and the like that can be suitably used to calculate a shade influence amount on a solar power generation amount.

2. Description of Related Art

In recent years, efforts toward carbon neutrality have been accelerated to solve the problem of climate change. For strengthening environmental measures to achieve carbon neutrality, measures such as making obligation of installing a solar power generation facility and limiting carbon dioxide emissions are being implemented.

On the other hand, when a building such as a mid-to-high-rise building is constructed, for example, solar radiation of a solar power generation facility near a construction site is interrupted, resulting in economic damage.

JP2003-167065A discloses a solar radiation simulation

system. The solar radiation simulation system sets a horizontal plane that corresponds to a target site and has a desired height with respect to a reference plane set in advance for the site. With respect to the horizontal plane, a solar radiation integral value due to sunshine obstructions installed adjacent to the site is calculated and displayed in different expressions differentiated according to the solar radiation integral value. In particular, the horizontal plane is expressed by forming a plurality of lattices according to the module dimensions set for the building, and calculating the solar radiation integral value for each lattice.

JP2013-37523A discloses a solar radiation simulation system. The solar radiation simulation system first launches 3D modeling software and reads two-dimensional map data (including floor number information) and floor height settings in the vicinity of the target building. Next, using the software's 3D conversion function, the area is converted into 3D. Next, additional correction processing is performed according to the actual building appearance and additional structures (for example, utility poles, and the like). A building to be verified (apartment complex) is additionally created on the planned construction site on the CAD software. The 3D data of the target area that has undergone the above processing is read into the CAD software.

Next, image processing is performed using the CAD software to vertically install heat collection panels on the balcony of each unit of the building to be verified. Information such as point information and azimuth angle is input into the CAD software, and a shade simulation calculation is executed.

SUMMARY OF THE INVENTION

A system for figuring out influence of building shade given on a peripheral solar power generation facility would be useful.

However, in the related art, the influence given on the solar power generation facility has not been evaluated by limiting to the shade of the target building. When there are a plurality of buildings, it is necessary to separate the shade affected by each building to more accurately evaluate the influence given on the peripheral solar power generation facility.

The present invention is to provide a shade influence amount evaluation system, a shade influence amount evaluation method, and a shade calculation system that can more accurately evaluate the influence of the shade of a building given on the peripheral solar power generation facility.

To solve the above problems, according to an

embodiment, there is provided a shade influence amount evaluation system including: a map data acquisition unit acquiring map data about a target building forming a shade and buildings in the vicinity of the target building; a sunshine-related data acquisition unit acquiring sunshine-related data being information about sunshine; a shade difference calculation unit calculating shade difference data being information on the shade of the target building excluding a shade of the buildings in the vicinity of the target building based on the map data and the sunshine-related data; and a peripheral influence evaluation unit evaluating a shade influence amount given on a solar power generation amount of an influenced building that is a building affected by the shade of the target building based on the shade difference data and the map data. Here, it is possible to provide a shade influence amount evaluation system that can more accurately evaluate the influence of the shade of the building on the peripheral solar power generation facility.

Herein, the peripheral influence evaluation unit can calculate an influence calculation range as a range affecting the solar power generation amount of the influenced building, and calculate the shade influence amount in the influence calculation range. Here, the estimation of the shade influence amount given on the solar

power generation amount can be refined.

The influence calculation range can be a position where a solar panel performing solar power generation is installed. Here, direct shade influence amount given on the solar panel can be calculated.

The peripheral influence evaluation unit can calculate the shade influence amount by considering an installation angle at which the solar panel is installed. Here, the estimation of the shade influence amount given on the solar power generation amount can be refined.

The influence calculation range can be at least one of a rooftop of the influenced building and a side of the influenced building. Here, a location where the solar power generation facility can be installed can be set as the influence calculation range.

The shade difference data can indicate a range of difference acquired by subtracting a shade range of the buildings in the vicinity of the target building from a shade range of the target building. Here, the influence of the shade of the buildings other than the target building can be eliminated.

The peripheral influence evaluation unit can calculate the shade influence amount for each piece of design data based on a plurality of pieces of design data about the target building not constructed yet. Here, an accurate

shade influence amount can be estimated in advance for each of a plurality of pieces of design data for the target building.

The shade difference calculation unit calculates each piece of shade difference data by using a plurality of pieces of map data in which the target building not constructed yet is disposed based on a plurality of pieces of design data in the map data of the vicinity of the target building. Here, map data can be prepared based on each of the plurality of pieces of design data.

Then, the peripheral influence evaluation unit can calculate the shade influence amount of the target building based on performance value related to at least one of the solar power generation amount and a solar radiation amount. Here, a more accurate shade influence amount can be calculated based on the performance values.

The performance value can be at least one of a power generation performance value, a measured solar radiation amount, and weather information. Here, more suitable data can be used as the performance value.

According to an embodiment, there is provided a shade influence amount evaluation method executed by a processor executing software stored in a memory, the method including: acquiring map data about a target building forming a shade and buildings in the vicinity of the target building;

acquiring sunshine-related data being information about sunshine; calculating shade difference data being information on the shade of the target building excluding a shade of the buildings in the vicinity of the target building based on the map data and the sunshine-related data; and evaluating shade influence amount given on a solar power generation amount of an influenced building that is a building affected by the shade of the target building based on the shade difference data and the map data. Here, it is possible to provide a shade influence amount evaluation method that can more accurately evaluate the influence of the shade of the building on peripheral solar power generation facility.

According to an embodiment, there is provided a shade calculation system including: a shade influence amount evaluation system evaluating a shade influence amount given on a solar power generation amount of an influenced building that is a building affected by a shade of a target building; and a terminal device displaying an evaluation result of the shade influence amount, in which the shade influence amount evaluation system includes a map data acquisition unit acquiring map data about the target building and buildings in the vicinity of the target building, a sunshine-related data acquisition unit acquiring sunshine-related data being information about sunshine, a shade

difference calculation unit calculating shade difference data being information on the shade of the target building excluding a shade of the buildings in the vicinity of the target building based on the map data and the sunshine-related data, and a peripheral influence evaluation unit evaluating the shade influence amount based on the shade difference data and the map data. Here, it is possible to provide a shade calculation system that can more accurately evaluate the influence of the shade of the building given on the peripheral solar power generation facility.

Herein, the terminal device can display an image comparing the shade influence amount for each of a plurality of pieces of design data about the target building not constructed yet. Here, the shade influence amount can be visually grasped.

The terminal device can display an image comparing the shade influence amount for each influenced building. Here, the shade influence amount for each influenced building can be visually grasped.

According to the present invention, there are provided a shade influence amount evaluation system, a shade influence amount evaluation method, and a shade calculation system that can more accurately evaluate an influence of a shade of a building on a peripheral solar power generation facility.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram illustrating a schematic configuration of an overall shade calculation system including a shade influence amount evaluation system according to the embodiment;

FIG. 2 is a diagram illustrating the configuration of a calculation server;

FIG. 3 is a diagram illustrating the configuration of a database server;

FIG. 4 is a sequence diagram illustrating an operation of the shade influence amount evaluation system;

FIG. 5 is a flowchart describing in detail a process performed by a data request processing unit of the database server in step S206 of FIG. 4;

FIG. 6 is a flowchart describing in detail a process performed by a shade difference calculation unit of the calculation server in step S211 of FIG. 4;

FIG. 7 is a flowchart describing in detail a process performed by a peripheral influence evaluation unit of the calculation server in step S216 of FIG. 4;

FIG. 8 is a diagram illustrating contents of condition data;

FIG. 9 is a diagram illustrating contents of a map model list;

FIG. 10 is a diagram illustrating contents of shade influence data;

FIG. 11A is a diagram illustrating a display example when a shade is drawn on a terminal in step S213 of FIG. 4, and FIGS. 11B, 11C and 11D are diagrams illustrating an influence calculation range described in step S369 of FIG. 7;

FIG. 12 is a diagram illustrating a case where an evaluation result of a shade influence amount is displayed on the terminal in step S218 of FIG. 4; and

FIG. 13 is a diagram illustrating a power generation performance value of a solar power generation facility installed in a target building or an influenced building.

DESCRIPTION OF EMBODIMENTS

<Overall Description of System Including Shade Influence Amount Evaluation System 1>

FIG. 1 is a diagram illustrating a general configuration of an overall shade calculation system S including a shade influence amount evaluation system 1 according to the embodiment.

The shade calculation system S illustrated in FIG. 1 includes a shade influence amount evaluation system 1 evaluating an influence of a shade, terminals 5a, 5b and 5c displaying an evaluation result of a shade influence amount

evaluated by the shade influence amount evaluation system 1, and an external system 7 that performs predetermined processing depending on the influence of the shade, all of which are connected with each other via a network 6.

The shade influence amount evaluation system 1 is a server computer managing the overall shade calculation system S illustrated in the drawings.

As will be described in detail later, the shade influence amount evaluation system 1 is a device calculating a shade influence amount, which is an amount of influence given on solar power generation by a shade formed by sunshine irradiating a building. Note that, hereinafter, a building forming a shade when calculating the shade influence amount may be referred to as a "target building". A building that is affected by the shade of the target building is sometimes referred to as an "influenced building". The target building can also be said to be a building that blocks sunshine and creates the shade. The influenced building can also be said to be a building that is affected by the shade of the target building. When the influenced building is affected by the shade of the target building, a power amount generated by a solar power generation facility installed on a rooftop of the influenced building decreases. Here, the shade influence amount evaluation system 1 calculates the shade influence amount,

which is the influence amount given on the solar power generation.

The shade influence amount evaluation system 1 includes a calculation server 2, a database server 3, and a communication control unit 4.

The calculation server 2 performs various calculations such as calculating the shade influence amount.

The database server 3 stores map data of the overall city, the target building, buildings in the vicinity of the target building, and the like. Herein, the map data is 3D (three-dimensional) map information. That is, the map data not only indicates positions and shapes of buildings when viewed from above, but also includes data in the height direction, indicating the positions and shapes of the buildings in a three-dimensional space.

The communication control unit 4 transmits and receives information to and from the terminals 5a, 5b, and 5c and the external system 7 via the network 6.

The terminals 5a, 5b, and 5c (terminals 1 to 3) are, for example, terminal devices through which a user requests the shade influence amount evaluation system 1 for evaluation of the shade influence amount or on which the evaluation results of the shade influence amount is displayed. In the first embodiment described later, a case will be described in which construction of the target

building is planned, and the terminal 5a is a terminal device operated by a construction planner who plans the construction of the target building. In a second embodiment described later, a case will be described in which the shade influence amount of the target building that has already been constructed is calculated, and the terminal 5b is a terminal device operated by an operator who operates the target building. The terminal 5c is a terminal device operated by a data manager who manages buildings such as the target building and buildings in the vicinity of the target building, or sunshine-related data such as a position of the sun and a sunshine amount. Although three terminals 5a, 5b, and 5c are illustrated in FIG. 1, the number may be any number as long as it is one or more. Note that hereinafter, when the terminals 5a, 5b, and 5c are not distinguished from each other, the terminals may be simply referred to as "terminal 5".

The terminal 5 is, for example, a computer device such as a general-purpose personal computer (PC), a mobile computer, a mobile phone, a smartphone, or a tablet.

The external system 7 is not particularly limited as long as the external system 7 is a device that receives the calculation result of the shade influence amount and performs a predetermined processing. The external system 7 is, for example, a device calculating a compensation amount

when damage occurs by a decrease in the solar power generation amount due to the shade of the target building in the second embodiment described later.

The external system 7 can be a computer device such as a PC or a server computer.

The shade influence amount evaluation system 1, the terminal 5, and the external system 7 include, for example, a processor such as a central processing unit (CPU) that controls each unit by executing programs, and a display device such as a display displaying images and other information. The shade influence amount evaluation system 1, the terminal 5, and the external system 7 include, for example, an input device such as a keyboard for inputting characters and a mouse. The shade influence amount evaluation system 1, the terminal 5, and the external system 7 include, for example, a communication interface (hereinafter referred to as "communication I/F") used for communication with an external device and a memory such as a random access memory (RAM) and a storage in which system data and internal data are stored.

The network 6 is a communication unit used for information communication between the shade influence amount evaluation system 1, the terminal 5, and the external system 7, and is, for example, Internet, a local area network (LAN), or a wide area network (WAN). The

communication line used for information communication may be wired or wireless, and both may be used in combination. The shade influence amount evaluation system 1, the terminal 5, and the external system 7 may be connected via a plurality of networks or communication lines using a relay device such as a gateway device or a router.

<Explanation of Shade Influence Amount Evaluation System 1>

[First Embodiment]

First, a first embodiment of the shade influence amount evaluation system 1 will be described.

In the first embodiment, the target building has not yet been constructed. The shade influence amount given on the solar power generation amount of peripheral buildings is evaluated based on the shade formed by the target building when constructed. Here, the shade influence amount evaluation system 1 calculates the shade influence amount for each piece of design data based on a plurality of pieces of design data about the target building that has not yet been constructed. The terminal 5 displays an image in which the shade influence amount is compared for each of the plurality of pieces of design data for the target building that has not yet been constructed.

FIG. 2 is a diagram illustrating the configuration of the calculation server 2.

As illustrated in the drawings, the calculation server 2 includes communication I/Fs 101a and 101b, a CPU 102, a memory 103, and a storage 104.

The communication I/Fs 101a and 101b exchange information with the database server 3 and the communication control unit 4.

The CPU 102 performs calculations for executing the processing performed by the calculation server 2. The CPU 102 functions as a map data acquisition unit acquiring map data about the target building and the buildings in the vicinity of the target building. The CPU 102 functions as a sunshine-related data acquisition unit acquiring sunshine-related data being information about sunshine. "Map data" is 3D map information as described above. The "sunshine-related data" includes information on the position of the sun and the sunshine amount for each date and time.

The memory 103 stores programs for implementing the functions of the shade difference calculation unit 105 and the peripheral influence evaluation unit 106, and the CPU 102 executes the programs.

As will be described in detail later, the shade difference calculation unit 105 calculates shade difference data 108, which is information on the shade of the target building excluding a shade of the buildings in the vicinity

of the target building, based on the map data and the sunshine-related data.

As will be described in detail later, the peripheral influence evaluation unit 106 evaluates the shade influence amount given on the solar power generation amount of the influenced building that is a building affected by the shade of the target building based on the shade difference data 108 and the map data. The "solar power generation amount" is the power amount generated by the solar power generation facility. The solar power generation facility is, for example, a power generation device that is installed on a rooftop or a roof of a building and uses a solar panel made of silicon solar cells, but is not limited thereto. For example, the solar power generation facility may be a power generation device using an organic thin-film solar cell. In the case of organic thin-film solar cells, it is easy to perform solar power generation by using not only the rooftop of the building but also the walls of the building.

The storage 104 stores data used by the programs executed by the CPU 102. The storage 104 stores various data such as condition data 107, the shade difference data 108, and shade influence data 109.

As to be described in detail later, the condition data 107 corresponds to each piece of data of a target point, a target period, and a target building information list, which

are used when evaluating the shade influence amount.

The shade difference data 108 is data indicating a range of difference acquired by subtracting a shade range of the buildings in the vicinity of the target building from a shade range of the target building.

The shade influence data 109 is data about the results of calculating the shade influence amount of the target building for each area in which the shade influence amount is calculated.

FIG. 3 is a diagram illustrating the configuration of the database server 3.

As illustrated in the drawings, the database server 3 includes communication I/Fs 121a and 121b, a CPU 122, a memory 123, and a storage 124.

The communication I/Fs 121a and 121b exchange information with the calculation server 2 and the communication control unit 4.

The CPU 122 performs calculations for executing the processing performed by the database server 3.

The memory 123 stores programs for implementing the functions of the data request processing unit 125 and the data update unit 126, and the CPU 122 executes the programs.

The data request processing unit 125 selects necessary data according to the data request from the calculation server 2.

When the calculation server 2 calculates the shade influence amount or when there is newly acquired data, the data update unit 126 updates various data stored in the storage 124 accordingly.

The storage 124 stores data used by programs executed by the CPU 122. The storage 124 stores various data such as target building information 127, a map model list 128, an overall map model 129, a peripheral map model 130, an integrated map model 131, and sunshine-related data 132.

The target building information 127 is a 3D model of the target building. The 3D model of the target building is, for example, a building information model (BIM). Data about the installation status of the solar power generation facility may be input into the target building information 127.

The map model list 128 is a list for managing the peripheral map model 130 and the integrated map model 131.

The overall map model 129 is the overall map data. The overall map model 129 is, for example, map data of the overall city or map data of the overall town.

The peripheral map model 130 is a 3D model of the buildings in the vicinity of the target building, extracted from the overall map model 129. The peripheral map model 130 is, for example, the overall map model 129 divided into meshes, and is a 3D model of the buildings in the vicinity

of the target building in areas divided by the meshes. One side of the mesh is, for example, 0.5 km. The peripheral map model 130 is, for example, a BIM model and is in the CityGML format. The CityGML format is a data format in which a building model and architectural information are linked.

The integrated map model 131 is a 3D model that integrates a 3D model of the target building and 3D models of the buildings in the vicinity of the target building. If there is a plurality of pieces of design data for the target building, the integrated map model 131 can also be said to be a plurality of pieces of map data in which a target building not constructed yet is disposed based on the plurality of pieces of design data in the map data of the vicinity of the target building. Therefore, hereinafter, the integrated map model 131 may be referred to as an integrated map model (group) 131. Accordingly, the map data based on each of the plurality of pieces of design data can be prepared.

As described above, the sunshine-related data 132 includes information on the position of the sun and the sunshine amount for each date and time. The sunshine-related data 132 is the annual sunshine performance value acquired from a sunshine amount database or data acquired from a building management system. The former is used in

the first embodiment described later. The latter is used in the second embodiment described later. The sunshine-related data 132 may include data such as solar power generation performance values/illuminance sensor measurement values and weather information during a specified period.

FIG. 4 is a sequence diagram illustrating an operation of the shade influence amount evaluation system 1. Herein, operations of the terminal 5, the calculation server 2, and the database server 3 are illustrated. More detailed operations about some of the illustrated steps will be described later.

First, the terminal 5 starts up a web browser (step S201). Then, the user operating the terminal 5 inputs calculation conditions (step S202). The calculation conditions include, for example, an address of the target building, a date and time of calculating the shade influence amount, design data of the target building, and the like.

The input calculation conditions are transmitted to the calculation server 2 and received by the calculation server 2 (step S203).

The calculation server 2 creates the condition data 107 based on the calculation conditions and requests necessary data to the database server 3 (step S204).

The created condition data 107 is transmitted to the

database server 3, and is received by the database server 3 (step S205).

In the database server 3, the data request processing unit 125 selects necessary data according to the data request from the calculation server 2 (step S206). The database server 3 selects data to be used by the calculation server 2 according to the calculation conditions. The data to be selected are, for example, the peripheral map model 130, the integrated map model 131, and the sunshine-related data 132.

The selected data is transmitted to the calculation server 2 and received by the calculation server 2 (step S207).

When the calculation server 2 receives the necessary data, the calculation server 2 notifies the terminal 5 that the calculation preparation has been completed (step S208).

At the terminal 5, the user inputs with a button to perform a shade calculation instruction (step S209).

The shade calculation instruction is transmitted to the calculation server 2, and received by the calculation server 2 (step S210).

In the calculation server 2, the shade difference calculation unit 105 calculates the shade difference data 108, which is the range of the shade of the target building excluding a shade of the buildings in the vicinity of the

target building (step S211). That is, the shade difference calculation unit 105 calculates the influence of the shade limited to the shade given by the target building itself to the peripheral area. Accordingly, the influence of the shade of the buildings other than the target building can be eliminated. Specifically, a shade when the target building does not exist (the shade of the peripheral map model 130) and the shade when the target building exists (the shade of the integrated map model 131) are calculated, and the difference therebetween is calculated as the shade difference data 108, which is the subject of the influence amount evaluation. The shade difference data may be a shade image when the integrated map model 131 is viewed from above, or may be a shade image when the integrated map model 131 is developed as a texture map.

After calculating the shade difference data 108, the calculation server 2 notifies the terminal 5 of the completion of the shade calculation (step S212).

The terminal 5 draws a shade on the display device based on the shade difference data 108 (step S213).

At the terminal 5, the user inputs evaluation conditions (step S214). The evaluation conditions include, for example, the designation of the design data of the target building, the designation of the influenced building, the date and time of the evaluation, and the like.

The input evaluation conditions are transmitted to the calculation server 2, and received by the calculation server 2 (step S215).

In the calculation server 2, the peripheral influence evaluation unit 106 evaluates the shade influence amount given on the solar power generation amount of the buildings in the vicinity of the target building based on the evaluation conditions (step S216).

After evaluating the shade influence amount, the calculation server 2 notifies the terminal 5 of the evaluation result (step S217).

The terminal 5 draws a comparison of the evaluation results on the display device based on the shade influence amount (step S218). That is, the terminal 5 displays an image in which the shade influence amount for each of the plurality of pieces of design data of the target building is compared. Accordingly, the shade influence amount can be visually grasped. Suggestions for determining which design data to adopt from a plurality of pieces of design data can be acquired.

Note that, here, compensation may be executed in cooperation with the external system 7 based on the evaluation results.

FIG. 5 is a flowchart describing in detail the process performed by the data request processing unit 125 of the

database server 3 in step S206 of FIG. 4.

First, the data request processing unit 125 receives the condition data 107 (step S301). As described above, the condition data 107 is a target point, a target period, and a target building information list used when evaluating the shade influence amount. Herein, the building information list is an ID list of target building information that is set as a calculation condition.

Next, the data request processing unit 125 reads the map model list 128 based on the condition data 107 (step S302).

Next, the data request processing unit 125 determines whether there is a peripheral map model 130 including the target point (step S303). That is, the data request processing unit 125 determines whether there is a peripheral model of which a range matches the target point. The target point in the condition data 107 is expressed in latitude and longitude, but since the number of digits is smaller than that in the map model list 128, the number of digits is adjusted by rounding, for example, and it is determined whether there is a matching value.

As a result, when there is a peripheral map model 130 that includes the target point (Yes in step S303), the data request processing unit 125 extracts the peripheral map model 130 (step S304). Note that a plurality of peripheral

map models 130 may be required.

The data request processing unit 125 determines whether there is a peripheral map model 130 corresponding to the target period included in the condition data 107 (step S305).

The peripheral map model 130 is updated at regular periods. The determination is made based on whether the peripheral map model 130 extracted in step S303 corresponds to the target period, and the latest peripheral map model 130 before the target period is selected. For example, when there are peripheral map models 130 of which information acquisition dates are 2019/10/02 and 2020/04/07, respectively, and the target period is 2020/01/01 to 2020/01/31, the peripheral map model 130 of 2019/10/02 is selected. However, when the information update date of the peripheral map model 130 is earlier than a certain threshold value, it is determined that there is no corresponding peripheral map model 130. The information update date is specified in conjunction with the information date of the overall map model 129.

In step S303 and step S305, when there is no corresponding peripheral map model 130 (No in step S303, No in step S305), the data request processing unit 125 reads the overall map model 129 corresponding to the target period (step S306).

Next, the data request processing unit 125 creates a peripheral map model 130 centered on the target point and stores the created peripheral map model 130 in the storage 124 (step S307).

The data request processing unit 125 updates the map model list 128 (step S308).

When there is a corresponding peripheral map model 130 in step S305, after step S308, the data request processing unit 125 reads the peripheral map model 130 (step S309).

Next, the data request processing unit 125 sequentially selects the target buildings from the target building information list included in the condition data 107 (step S310). That is, the data request processing unit 125 repeats the operation of selecting one of the plurality of pieces of design data of the target building until all of the data have been selected.

Then, the data request processing unit 125 determines whether the selected target building is included in the corresponding calculated model list (step S311). As will be described in detail later, the calculated model list is included in the map model list 128. The data request processing unit 125 makes the determination based on whether the calculated model list and the target building (ID) match.

As a result, when the selected target building is in the corresponding calculated model list (Yes in step S311),

the data request processing unit 125 reads the integrated map model 131 (step S312).

On the other hand, when the target building is not in the corresponding calculated model list (No in step S311), the data request processing unit 125 reads the peripheral map model 130 (step S313).

Next, the data request processing unit 125 reads the target building information 127 (step S314).

Then, the data request processing unit 125 disposes the target building model in the peripheral map model 130 according to the target building information 127 (step S315).

The data request processing unit 125 stores the map model of S315 as the integrated map model 131 in the storage 124 (step S316).

The data request processing unit 125 updates the map model list 128 (step S317).

After step 312 and step S317, the data request processing unit 125 determines whether processing has been completed for all pieces of data in the target building information list (step S318).

As a result, when the process is not completed (No in step S318), the process returns to step S310.

On the other hand, when the processing is completed (Yes in step S318), the data request processing unit 125 transmits the integrated map model (group) 131 and the

peripheral map model 130 to the calculation server 2 (step S319, step S207 of FIG. 4).

Next, the data request processing unit 125 reads the sunshine-related data 132 corresponding to the conditions (step S320). Here, the data request processing unit 125 reads the sunshine-related data 132 in which the target point and target period match as conditions.

Then, the data request processing unit 125 transmits the sunshine-related data 132 to the calculation server 2 (step S321, step S207 in FIG. 4).

FIG. 6 is a flowchart describing in detail the process performed by the shade difference calculation unit 105 of the calculation server 2 in step S211 of FIG. 4.

First, the shade difference calculation unit 105 reads the condition data 107 created in step S204 of FIG. 4 (step S331).

Next, the shade difference calculation unit 105 reads the sunshine-related data 132 transmitted from the database server 3 (step S332).

Next, the shade difference calculation unit 105 reads the integrated map model (group) 131 and the peripheral map model 130 (step S333).

The shade difference calculation unit 105 selects the peripheral map model 130 (step S334).

Next, the shade difference calculation unit 105 sets

the sun position and the sunshine amount at the specified date and time based on the sunshine-related data 132 (step S335).

The shade difference calculation unit 105 executes the shade calculation (step S336). The calculation result is the result of calculating the range of shade affecting the buildings in the vicinity of the target building.

The shade difference calculation unit 105 saves the result of the shade calculation as the shade calculation result of the peripheral map model 130 (step S337). The result of the shade calculation is the result of calculating the range of shade of the buildings in the vicinity of the target building, and is the result when the target building does not exist.

Then, the shade difference calculation unit 105 determines whether calculation has been completed at all dates and times within the target period (step S338).

As a result, when the calculation has not been completed (No in step S338), the process returns to step S335.

On the other hand, when the calculation has been completed (Yes in step S338), the integrated map models 131 are sequentially selected (step S339). That is, the shade difference calculation unit 105 repeats the operation of selecting one of the plurality of pieces of design data of

the target building until all of the data are selected.

Then, the shade difference calculation unit 105 sets the sun position and the sunshine amount at the specified date and time based on the sunshine-related data 132 (step S340).

Next, the shade difference calculation unit 105 executes the shade calculation (step S341). The calculation result is the result of calculating the range of shade when the target building and the buildings in the vicinity of the target building are combined.

The shade difference calculation unit 105 stores the result of the shade calculation as the shade calculation result of the integrated map model 131 (step S342).

Then, the shade difference calculation unit 105 calculates the difference between the shade calculation result of the peripheral map model 130 and the above result (step S343). The difference is the result of calculation for the range of the shade of the target building excluding the shade of the buildings in the vicinity of the target building.

Next, the shade difference calculation unit 105 adds the calculated difference value to the shade difference data 108 (step S344).

The shade difference calculation unit 105 determines whether calculation has been completed at all dates and

times within the target period (step S345).

As a result, when the calculation has not been completed (No in step S345), the process returns to step S340.

On the other hand, when calculation has been completed (Yes in step S345), the shade difference data 108 is stored in the storage 104 (step S346).

Then, the shade difference calculation unit 105 determines whether the processing for all integrated map models 131 has been completed (step S347).

As a result, when the process is completed (Yes in step S347), a series of the processes ends.

On the other hand, when the process has not been completed, the process returns to step S339.

FIG. 7 is a flowchart describing in detail the process performed by the peripheral influence evaluation unit 106 of the calculation server 2 in step S216 of FIG. 4.

First, the peripheral influence evaluation unit 106 reads the condition data 107 created in step S204 of FIG. 4 (step S361).

Next, the peripheral influence evaluation unit 106 creates the shade influence data 109 for each piece of condition data 107 (step S362).

Next, the peripheral influence evaluation unit 106 sequentially selects the target buildings from the target

building information list included in the condition data 107 (step S363). That is, the peripheral influence evaluation unit 106 repeats the operation of selecting one of the plurality of pieces of design data of the target building until all of the data are selected.

Then, the peripheral influence evaluation unit 106 reads the integrated map model 131 and the shade difference data 108 corresponding to the selected target building (step S364).

The peripheral influence evaluation unit 106 compiles statistics of the shade difference data for the target period included in the condition data 107, and calculates the shade range corresponding to the selected target building (step S365).

Next, the peripheral influence evaluation unit 106 extracts a list of buildings in the integrated map model 131 (step S366). The buildings are located in the vicinity of the target building.

Then, the peripheral influence evaluation unit 106 sequentially selects the buildings in the vicinity of the target building (step S367).

The peripheral influence evaluation unit 106 determines whether the selected building is located within the shade area (step S368).

As a result, when the selected building is within the

shade range (Yes in step S368), the peripheral influence evaluation unit 106 specifies the influence calculation range (step S369). The influence calculation range is a target range for calculating the shade influence amount. That is, even when the selected building is within the shade area of the target building, the selected building will not directly affect the solar power generation amount, but the solar power generation amount is affected by the influence of the shade on the solar panel or the like of the solar power generation facility. Therefore, in the embodiment, the peripheral influence evaluation unit 106 calculates the influence calculation range as a range that affects the solar power generation amount of the influenced building, and calculates the shade influence amount in the influence calculation range. Accordingly, the shade influence amount given on the solar power generation amount becomes more accurate. The influence calculation range designates, for example, the overall building, the rooftop of the building, or the location where the solar panel performing solar power generation installed (facility installation area). It is a process of limiting the target range for calculating the shade influence amount using building information (for example, BIM data). The location and size of the solar power generation facility can be estimated from the texture data included in the integrated map model 131.

By setting the influence calculation range to the position where the solar panel is installed, it is possible to calculate the amount of direct shade influence on the solar panel. The peripheral influence evaluation unit 106 may calculate the shade influence amount by considering the installation angle at which the solar panel is installed. The influence calculation range may be the side (wall) of the influenced building. By setting the influence calculation range to be the rooftop or the side of the influenced building, the influence calculation range can include locations where the solar power generation facility can be installed. The rooftop is a place where the solar panels are mainly expected to be installed. The sides of influenced buildings are where organic thin-film solar cells are mainly expected to be installed.

Then, the peripheral influence evaluation unit 106 calculates the shade influence amount within the influence calculation range at the specified time (step S370). Note that herein, the shade influence amount is evaluated for each target shade, but the evaluation of the shade influence amount may be attempted using the cumulative result of the target shade.

The peripheral influence evaluation unit 106 adds the shade influence amount to the shade influence data 109 (step S371).

Next, the peripheral influence evaluation unit 106 determines whether calculation has been completed at all dates and times within the target period (step S372).

As a result, when the calculation has not been completed (No in step S372), the process returns to step S370.

On the other hand, when the calculation has been completed (Yes in step S372), the peripheral influence evaluation unit 106 determines whether the processing has been completed for all buildings (step S373).

As a result, when the process has not been completed (No in step S373), the process returns to step S367.

On the other hand, when the process has been completed (Yes in step S373), the peripheral influence evaluation unit 106 stores the shade influence data 109 in the storage 104 (step S374).

The peripheral influence evaluation unit 106 determines whether all pieces of data of the target building included in the target building information list has been processed (step S375).

As a result, when the process has not been completed (No in step S375), the process returns to step S363.

On the other hand, when the process has been completed (Yes in step S375), a series of the processes ends.

FIG. 8 is a diagram illustrating the contents of the

condition data 107.

The illustrated condition data 107 includes a condition ID 401, a target point 402, a target period 403, and a target building list 404.

The condition ID 401 is an ID given to each condition data 107. Herein, it is illustrated that at least two pieces of condition data 107 exist, and C001 and C002 are set as the condition ID 401 for each piece of data.

The target point 402 indicates the position of the target building of which shade influence amount is to be evaluated in terms of latitude and longitude.

The target period 403 indicates a period for which the shade influence amount is to be evaluated, expressed by dates.

The target building list 404 is a list of target buildings, and herein, the condition ID 401 indicates that design data of at least two target buildings are included for each of "C001" and "C002". For example, when the condition ID 401 is "C001", the design data of the target building includes at least two "Model01B" and "Model06B". Note that the target building list 404 may include information on the installation location of the solar power generation facility and the installation angle of the solar panel. When solar power generation using a solar panel is performed, due to a structure of the solar panel, when a

portion of the solar panel is affected by the shade, a power amount generated may decrease significantly. By using information on the installation location of the solar power generation facility and the installation angle of the solar panel, the estimation of the shade influence amount given on the solar power generation amount can be refined.

FIG. 9 is a diagram illustrating the contents of the map model list 128.

The map model list 128 includes information on the created peripheral map model 130 (peripheral map ID 411, target area 412, information acquisition date 413) and a calculated model list 414 corresponding thereto.

The peripheral map ID 411 is an ID given to each peripheral map model 130. Herein, it is illustrated that there are at least three peripheral map models 130, and that M001_01, M002_01, and M001_02, each indicated by reference numerals 415 to 417, are set as peripheral map IDs 411.

The target area 412 indicates the area where the peripheral map model 130 is created in terms of latitude and longitude.

The information acquisition date 413 indicates the date when the peripheral map model 130 is acquired.

The calculated model list 414 is a list of the integrated map models 131.

FIG. 10 is a diagram illustrating the contents of the

shade influence data 109.

The illustrated shade influence data 109 includes a condition ID 421, an integrated map ID 422, a building ID 423, a date and time 424, a shade influence amount 425, and a specified range type 426.

The condition ID 421 indicates the condition ID 107 used to calculate the shade influence data 109. Herein, indication of reference numerals 427 to 430 denotes that condition ID 107 of C001 is used.

The integrated map ID 422 is an ID assigned to each created integrated map model 131. The integrated map ID 422 is configured with the model names of the peripheral map model 130 + the target building list 404. For example, when the integrated map ID 422 is "M001_01_Model01B", the peripheral map model 130 is "M001_01" indicated by the reference numeral 415 in FIG. 9, and the model name of the target building list 404 is "Model01B" indicated by the target building list 404 of FIG. 8.

The building ID is an ID assigned to a building in the vicinity of the target building selected in step S367 of FIG. 7.

The date and time 424 is the date and time when the shade influence amount is evaluated. The date and time interval depends on specifications of data and simulation.

The shade influence amount 425 is a numerical value

of the shade influence amount. The shade influence amount 425 indicates illuminance and power generation amount.

The specified range type 426, which will be described in detail later with reference to FIGS. 11A to 11D, indicates the type of influence calculation range. Herein, there are three types of A to C.

FIG. 11A is a diagram illustrating a display example when a shade is drawn on the terminal 5 in step S213 of FIG. 4.

In FIG. 11A, the shade range excluding the shade of the buildings in the vicinity of a target building 501 is illustrated as a shade difference 505. The range affected by the shade difference 505 in influenced buildings 502 to 504 is illustrated. Note that here, the case is illustrated where the target building 501, the influenced buildings 502 to 504, and the shade difference 505 are viewed from above, and the top surfaces of the target building 501 and the influenced buildings 502 to 504 are displayed, but the viewpoint can be freely set, and the side view may be displayed.

FIGS. 11B to 11D are diagrams illustrating the influence calculation range described in step S369 of FIG. 7.

Among the drawings, FIG. 11B illustrates a case where the overall building of the influenced building 502 is set

as the influence calculation range. Here, the influence calculation range is a range 506. Here, the specified range type 426 in FIG. 10 is type A.

FIG. 11C illustrates a case where a building rooftop of the influenced building 502 is set as the influence calculation range. When viewed from above, the influenced building 502 is configured with a rooftop 502a and a low-rise portion 502b located at a lower level than the rooftop 502a. When the influence calculation range is the building rooftop, the influence calculation range is a range 507. Here, the specified range type 426 in FIG. 10 is type B.

FIG. 11D illustrates a case where a solar power generation facility installation area of the influenced building 502 is set as the influence calculation range. The solar power generation facility is installed on the rooftop 502a of the influenced building 502, and when the location is set as the influence calculation range, the influence calculation range is a range 508. Here, the specified range type 426 in FIG. 10 is type C.

FIG. 12 is a diagram illustrating a case where the evaluation result of the shade influence amount is displayed on the terminal 5 in step S218 of FIG. 4.

Herein, a case is illustrated in which the shade influence amount for the influence building 504 indicated by a D building is evaluated. Here, when the influenced

building 504 is selected by clicking with a mouse or the like, the evaluation result of the shade influence amount for the influenced building 504 is displayed as a window W1. Note that other influenced buildings can also be selected. That is, the terminal 5 can display an image in which the shade influence amount is compared for each influenced building. Accordingly, the shade influence amount for each influenced building can visually grasped. The shade influence amount for each influenced building can be evaluated.

A title 511, a date and time 512, a shade influence amount 513, and a comparison result 514 are displayed in the window W1.

The title 511 indicates that the influenced building 504 is a "D building" and that the target building 501 is based on the design data of "Model01A".

The date and time 512 is the date and time when the shade influence amount is evaluated.

The shade influence amount 513 displays the shade influence amount on the date and time 512 as time series data. Herein, the shade influence amount 513 is configured with a total of the shade influence amount and a value of the shade difference amount.

The comparison result 514 is a table comparing the shade influence amount depending on the type of the target

building 501. That is, the shade influence amount for the influenced building 504 is compared for each piece of design data of the target building 501.

In the first embodiment, a more accurate shade influence amount can be estimated in advance before construction of the target building. For each of a plurality of pieces of design data for the target buildings for the target building, the shade influence amount can be more accurately estimated in advance. Therefore, it is possible to take measures such as selecting one piece of design data among a plurality of pieces of design data of which the shade has less influence on the peripheral buildings.

[Second Embodiment]

Next, a second embodiment of the shade influence amount evaluation system 1 will be described.

In the second embodiment, the target building includes all of a building not constructed yet and a building already constructed. Based on the shade formed by the target building not constructed yet or already constructed, the shade influence amount given on the solar power generation amount of the peripheral buildings is evaluated. Here, the shade influence amount evaluation system 1 calculates the shade influence amount given by the target building not constructed yet or already constructed based on performance

values related to at least one of the solar power generation amount and the solar radiation amount. For example, the external system 7 calculates the amount of compensation when the solar power generation amount decreases due to the shade of the target building and damage occurs, based on the calculated shade influence amount.

In the first embodiment, the shade influence amount is not calculated based on the performance values related to the solar power generation amount and the solar radiation amount. That is, in the first embodiment, since the solar radiation amount common to the overall area in a normal year is used, there is a possibility that the difference from the actual solar radiation amount becomes large. For example, when the sunshine amount decreases due to bad weather, the actual solar radiation amount decreases.

In the second embodiment, the shade influence amount given by the target building not constructed yet or already constructed is evaluated based on the performance values related to the solar power generation amount and the solar radiation amount. The performance values related to the solar power generation amount and the solar radiation amount is, for example, the power generation performance value of the solar power generation facility installed in the target building or the influenced building, or a measured value of the solar radiation sensor (measured solar radiation amount).

In the second embodiment as well, the shade influence amount can be evaluated by using the same method as in the first embodiment. However, in the second embodiment, when the target building has already been constructed, there is only one piece of design data of the target building that is to be the calculation target. Accordingly, in the first embodiment, a plurality of target buildings are listed in the target building list 404 of the condition data 107 in FIG. 8, but when the target building is already constructed, calculation may be performed for the actually constructed target building.

FIG. 13 is a diagram illustrating the power generation performance value of the solar power generation facility installed in the target building or the influenced building.

The illustrated power generation performance value 604 is determined for each item of an ID 601, a date 602, and a period 603. That is, the power generation performance value 604 within the date 602 and the period 603 are arranged.

Herein, although the power generation performance value and the measured value of the solar radiation sensor (solar radiation amount measurement) are cited as the performance value, weather information can also be used as the performance value. By setting the performance value as the power generation performance value, the measurement value of the solar radiation sensor (measured solar

radiation amount), or weather information, more suitable data can be used as the performance value.

In the second embodiment, the actual data of the year is used instead of the average/area-wide data. Accordingly, a more accurate shade influence amount can be calculated based on the performance values.

<Description of Shade Influence Amount Evaluation Method>

The processing performed by the shade influence amount evaluation system 1 described above is implemented by cooperation of software and hardware resources. That is, the processor inside the computer provided in the shade influence amount evaluation system 1 loads software for implementing each of the above-mentioned functions into the memory and executes the software, thereby implementing each function.

Therefore, the process performed by the shade influence amount evaluation system 1 can be grasped as a shade influence amount evaluation method executed by a processor executing software stored in a memory, the method including: acquiring map data about a target building forming a shade and buildings in the vicinity of the target building; acquiring sunshine-related data 132 being information about sunshine, calculating shade difference data being information on the shade of the target building

excluding a shade of the buildings in the vicinity of the target building based on the map data and the sunshine-related data 132; and evaluating the shade influence amount given on a solar power generation amount of an influenced building that is a building affected by the shade of the target building based on the shade difference data and the map data.

Although the embodiment has been described above, the technical scope of the present invention is not limited to the scope described in the above embodiment. It is clear from the claims that various changes or improvements made to the above embodiments are also included within the technical scope of the present invention.

What is claimed is:

1. A shade influence amount evaluation system comprising:

a map data acquisition unit acquiring map data about a target building forming a shade and buildings in the vicinity of the target building;

a sunshine-related data acquisition unit acquiring sunshine-related data being information about sunshine;

a shade difference calculation unit calculating shade difference data being information on the shade of the target building excluding a shade of the buildings in the vicinity of the target building based on the map data and the sunshine-related data; and

a peripheral influence evaluation unit evaluating a shade influence amount given on a solar power generation amount of an influenced building that is a building affected by the shade of the target building based on the shade difference data and the map data.

2. The shade influence amount evaluation system according to claim 1, wherein the peripheral influence evaluation unit calculates an influence calculation range as a range affecting the solar power generation amount of the influenced building, and calculates the shade influence amount in the influence calculation range.

3. The shade influence amount evaluation system according to claim 2, wherein the influence calculation range is a location where a solar panel performing solar power generation is installed.

4. The shade influence amount evaluation system according to claim 3, wherein the peripheral influence evaluation unit calculates the shade influence amount by considering an installation angle at which the solar panel is installed.

5. The shade influence amount evaluation system according to claim 2, wherein the influence calculation range is at least one of a rooftop of the influenced building and a side of the influenced building.

6. The shade influence amount evaluation system according to claim 1, wherein the shade difference data indicates a range of difference acquired by subtracting a shade range of the buildings in the vicinity of the target building from a shade range of the target building.

7. The shade influence amount evaluation system according to claim 1, wherein the peripheral influence

evaluation unit calculates the shade influence amount for each piece of design data based on a plurality of pieces of design data about the target building not constructed yet.

8. The shade influence amount evaluation system according to claim 7, wherein the shade difference calculation unit calculates each piece of shade difference data by using a plurality of pieces of map data in which the target building not constructed yet is disposed based on a plurality of pieces of design data in the map data of the vicinity of the target building.

9. The shade influence amount evaluation system according to claim 1, wherein the peripheral influence evaluation unit calculates the shade influence amount of the target building based on a performance value related to at least one of the solar power generation amount and a solar radiation amount.

10. The shade influence amount evaluation system according to claim 9, wherein the performance value is at least one of a power generation performance value, a measured solar radiation amount, and weather information.

11. A shade influence amount evaluation method

executed by a processor executing software stored in a memory, the method comprising:

- acquiring map data about a target building forming a shade and buildings in the vicinity of the target building;

- acquiring sunshine-related data being information about sunshine;

- calculating shade difference data being information on the shade of the target building excluding a shade of the buildings in the vicinity of the target building based on the map data and the sunshine-related data; and

- evaluating the shade influence amount given on a solar power generation amount of an influenced building that is a building affected by the shade of the target building based on the shade difference data and the map data.

12. A shade calculation system comprising:

- a shade influence amount evaluation system evaluating a shade influence amount given on a solar power generation amount of an influenced building that is a building affected by a shade of a target building; and

- a terminal device displaying an evaluation result of the shade influence amount, wherein

- the shade influence amount evaluation system includes

- a map data acquisition unit acquiring map data about the target building and buildings in the vicinity of the

target building;

a sunshine-related data acquisition unit acquiring sunshine-related data being information about sunshine;

a shade difference calculation unit calculating shade difference data being information on the shade of the target building excluding a shade of the buildings in the vicinity of the target building based on the map data and the sunshine-related data; and

a peripheral influence evaluation unit evaluating the shade influence amount based on the shade difference data and the map data.

13. The shade calculation system according to claim 12, wherein the terminal device displays an image comparing the shade influence amount for each of a plurality of pieces of design data about the target building not constructed yet.

14. The shade calculation system according to claim 13, wherein the terminal device displays an image comparing the shade influence amount for each influenced building.