

SPECIFICATION

TITLE OF THE INVENTION

IMAGE DISPLAY SYSTEM AND METHOD

5

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority from Japanese Patent Application No. 2018-124978 filed on June 29, 2018, the content of which is hereby incorporated by reference into this application.

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TECHNICAL FIELD OF THE INVENTION

[0001]

The present invention relates to a process and a display technique for a group of images. Moreover, the present invention
15 also relates to a technique that is effectively applicable to deterioration inspection support for a structural object or others.

BACKGROUND OF THE INVENTION

[0002]

20 In various usages, a user takes pictures of a group of images (motion picture images or a plurality of still images) by using a camera, and inputs the images to a computer such as a PC. On a display screen, the user displays the group of images that have been processed by the computer and individual images selected from the
25 group of images. On the display screen, the user checks the group of images and individual images, and carries out an operation in accordance with its usage. As the operation, for example, a general editing operation for photographic images is cited.

[0003]

30 As one example of the usage for dealing with the above-described group of images, a system and a function (referred to as "structural object deterioration inspection or others" in some

cases) for inspecting and diagnosing states of the structural object such as deterioration of the surface from an image obtained by photographing the surface of the structural object are cited. A user, who is an operator for carrying out maintenance and inspecting operation, takes pictures of the surface of the structural object that is a maintenance and inspecting operation target through a camera, manually or by using a drone, a robot or others. As the structural object, various architectures, infrastructural facilities, and others are cited. The user inputs a group of images photographed by a camera to a computer, and displays the group of images that have been processed by the computer on a display screen. On the display screen, the user selects an individual image that is an inspection target from the group of images, and displays the image on the display screen. The user carries out an operation such as a visual inspection. In this case, the user views the individual image on the display screen, and visually checks and detects the presence/absence of states such as cracking, corrosion, peeling off and others (generally referred to as deterioration in some cases) and checks and detects its position.

[0004]

As another usage example for dealing with the above-described group of images, a system and a function (referred to as "structural-object three-dimensional model generation or others in some cases) for generating and obtaining a three-dimensional model of the structural object and displaying it on the display screen from an image obtained by photographing the surface of the structural object on the basis of a process such as a publicly-known SFM (Structure For Motion) are cited.

[0005]

As a related-art example to the above-described image display, Japanese Patent Application Laid-open Publication No. 2000-90232 (Patent Document 1) is cited. For a panorama image composition

device or others, Patent Document 1 describes a step of generating a panorama image by photographing images through a digital camera while a photographic subject image is divided into a plurality of segments so that the images partially overlap and of composing the plurality of images obtained by the photographing process, a step of simultaneously displaying the entire preview of the panorama image and a partial preview thereof on the same window, and other steps.

[0006]

Moreover, as a related-art example to the above-described structural object deterioration inspection, Japanese Patent Application Laid-open Publication No. H11-132961 (Patent Document 2) is cited. For an inspection device for the structural object, the Patent Document 2 describes a technique of photographing images while an inspection subject image is divided into a plurality of segments, storing image data with corresponding positional information and photographing information in the plurality of photographed image data, and specifying an inspection position of the inspection subject is specified, so that image data is selected, and the image formed by connecting the plurality of image data on the inspection position and a position around the inspection position is displayed.

SUMMARY OF THE INVENTION

[0008]

In a conventional image display system, when the user selects the individual image for a specific usage on the display screen from the group of images, there are cases in which it is difficult to select suitable images and in which long time and large effort for the operation are required. For example, in the usage case of the structural-object deterioration inspection support, the user needs to select an inspection target image from a large number of images

on the display screen. At this time, it sometimes becomes difficult to select the suitable images having less overlapped segments among the images, and therefore, long time and large effort are required for the deterioration inspecting operation.

5 [0009]

An object of the present invention relates to an image display technique, and is to provide a technique capable of, in selection of an image for a predetermined usage from a group of images photographed by a camera, easily selecting a suitable image so that
10 time and effort for the user's operation can be reduced.

[0010]

A typical embodiment of the present invention relates to an image display system, and a feature of the typical embodiment is to include the following configurations. The image display system
15 according to one embodiment is an image display system configured by a computer system, and the computer system inputs a group of images including a plurality of images each of which has different photographing time and date, position and direction, displays a list of the group of images on a list screen, displays a first image
20 selected from the group of images on the basis of a user's operation on an individual screen, determines an adjacent image relative to the first image on the basis of determination of spatial positional relation between a pair of the first image and a candidate image spatially located on the periphery of the first image and
25 determination of an overlap state in a photographing area, selects the adjacent image relative to the first image on the individual screen as a second image on the basis of the user's operation, and displays the second image as a newly-formed first image.

[0011]

30 According to the typical embodiment of the present invention relating to an image display technique, when an image for a predetermined usage is selected from a group of images photographed

by a camera, a suitable image can be easily selected, so that time and effort for a user's operation can be reduced.

BRIEF DESCRIPTIONS OF THE DRAWINGS

5 [0012]

FIG. 1 is a view showing a configuration of a structural object deterioration inspection support system including an image display system of an embodiment of the present invention;

FIG. 2 is a view showing a configuration of a cooperation state
10 between a drone and a computer system in the embodiment;

FIG. 3 is a view showing a configuration of an image display system of the embodiment;

FIG. 4 is a view showing a processing flow of the image display system of the embodiment;

15 FIGS. 5A and 5B are views each showing a first example of an aerial photographing system for a structural object in the embodiment;

FIGS. 6A and 6B are views each showing a second example of the aerial photographing system for the structural object in the
20 embodiment;

FIG. 7 is a view showing a photographing area in the embodiment;

FIG. 8 is a view showing an overlap state between images in an aerial-photography traveling direction;

25 FIG. 9 is a view showing an overlap state between images in an image plan view;

FIG. 10 is a view showing an example of an adjacent image and an overlap state in the embodiment;

FIG. 11 is a view showing an overlap state in a photographing
30 area in the embodiment;

FIG. 12 is a view showing an overlap state in an adjacent image in the embodiment;

FIG. 13 is a view showing SFM in the embodiment;

FIG. 14 is a view showing a first example of a list screen in the embodiment;

FIG. 15 is a view showing a first example of an individual
5 screen in the embodiment;

FIG. 16 is a view showing a second example of the individual screen in the embodiment;

FIG. 17 is a view showing a third example of the individual screen in the embodiment;

10 FIG. 18 is a view showing a fourth example of the individual screen in the embodiment;

FIGs. 19A to 19C are views each showing a fifth example of the individual screen in the embodiment;

FIG. 20 is a view showing a sixth example of the individual
15 screen in the embodiment;

FIG. 21 is a view showing an example of an individual screen (deterioration inspection screen) in the embodiment;

FIG. 22 is a view showing an example of a structural-object three-dimensional model screen in the embodiment;

20 FIG. 23 is a view showing a second example of a list screen in the embodiment;

FIG. 24 is a view showing a third example of the list screen in the embodiment;

FIG. 25 is a view showing an example of an image relation
25 between side surfaces in a structural object in the embodiment;

FIG. 26 is a view showing an image selection between side surfaces in a structural object in the embodiment; and

FIGs. 27A and 27B are views each showing a third example of an aerial photographing system of a structural object in the
30 embodiment.

DESCRIPTIONS OF THE PREFERRED EMBODIMENTS

[0013]

Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings. Note that the same components are denoted by the same reference
5 symbols throughout all the drawings for describing the embodiments, and the repetitive description thereof will be omitted.

[0014]

[Problems and Others]

Additional explanation will be made on a premise technique,
10 problems and others of. Conventionally, for example, in the usage of the structural-object deterioration inspection support and such a system, the following operations and processes are carried out. A user who is an operator visits an actual site where a structural object serving as an inspection target is located, and photographs
15 a surface of the structural object by using a camera. At this time, the user may photograph all the regions on the surface of the structural object, or may narrow down the regions to and photograph one region. In particular, a person having knowledge of the structural object (expert engineer) may previously narrow down the
20 regions to a part where deterioration is probably easily caused from designing drawings of the structural object or others, and may set the part as a photographing target part. In this case, the part to be photographed and the number of images are limited, so that time and effort for the operation can be reduced.

25 [0015]

The user brings data of a group of photographed images back to an office or others, and inputs the data into a computer, such as a PC. On a display screen, the user selects individual images serving as the inspection target images from a list of the group
30 of images, and displays them on the display screen. In a visual inspection, for each image, the user visually checks and searches presence or absence of a deteriorated state such as cracking and

a position of the deterioration from the image.

[0016]

The above-described manual photographing operation and deterioration inspecting operation for the structural object need
5 long time and large effort. Moreover, there are also general problems such as a lack of members of the expert engineers or others, high costs, etc. Therefore, as countermeasures, a technique for photographing the structural object by using a flight vehicle such as a drone or a UAV, a robot or others is cited. In one example
10 of this technique, while a drone is autonomously flown, the surface region of the structural object is photographed to, for example, be entirely covered by using a camera mounted on the drone, so that the group of images are automatically obtained. Thus, the user's narrowing-down operation for the inspection target, the manual
15 photographing operation at the actual site and others can be reduced. Moreover, works such as the maintenance check and the deterioration inspection for the structural object can be efficiently carried out.
[0017]

Moreover, also in a usage case for generating a
20 three-dimensional model of the structural object from the group of images also, time and effort are similarly required for the manual photographing operation or others. Also in this case, the photographing operation or others can be reduced by utilizing the drone or others. From the group of input images, the computer
25 generates the three-dimensional model of the structural object on the basis of an SFM process. Thus, for example, even in a case of a structural object having only a two-dimensional designing drawing, the three-dimensional model can be obtained and displayed on the display screen, and effectively utilized for management of the
30 structural object or others.
[0018]

The group of images manually obtained or obtained by a drone

or others is a group of images obtained by, for example, photographing a surface region of a target object to be entirely covered, and has an overlapped segment among the images in many cases. That is, between one image and another image positioned on the periphery of the image in the spatial positional relation, partial regions each of which has the same photographed part in the contents of the image overlap each other. In the usage for the deterioration inspection, in order to fully inspect the surface region of the structural object, at the time of photographing the group of images, the partial images are photographed to be overlapped so as to have a margin for avoiding a photographing failed region. Moreover, in particular, in the usage for generating the three-dimensional model, a group of images having sufficient overlapped segments among the images is required as conditions required for applying a publicly-known SFM process thereto. For example, the overlapped segments of 80% or more are required in a lateral direction of the image corresponding to a direction of a movement of the camera, and the overlapped segments of 60% or more are required in a longitudinal direction thereof.

[0019]

Moreover, the surface region on an appearance of the structural object has many similarly-shaped parts because of an architectural structure, a wall face design and others. That is, the image contents of the group of images have many similar parts. For this reason, when the user checks a certain image, it may be difficult to recognize which part has been photographed as the image. Furthermore, it may be difficult to recognize the spatial positional relation which one is the image on the periphery of the certain image.

[0020]

For this reason, when the user selects an individual image serving as an operation target from a list of the group of images on the display screen, it may be difficult to select a suitable image.

For example, in the usage for the deterioration inspection, the user may desire to visually inspect a region in one certain image, and then, visually inspect a region adjacent to the region of this image as a target. However, for the user, it is difficult to select the image in the adjacent region because there are many similar points in the image contents among the images so that different point are difficult to be found and because it is difficult to recognize the positional relation among the images. Moreover, when the user successively simply selects a next image of the certain image from the list of the group of images, the selected image is not always the image in the adjacent region, and may be an image located at a distant position.

[0021]

Moreover, it is assumed that the user selects the next image (second image) on the display screen by determining the image contents and the spatial positional relation by himself or herself from the certain image (first image). It is assumed that, for example, the user determines that the same object was photographed in two images. Even in such a case, the next image may include a region, which has been already inspected in the first image, as an overlapped region in many cases. In the contents of the group of images, the overlapped region is generated among the images depending on a usage and a case such as a case in which the surface region of the structural object is fully photographed in detail and a case in which the three-dimensional model is generated. For this reason, the overlapped region of the next image is undesirably contained again as the visual inspection target, and therefore, the user's burden increases. Since each of many images has many overlapped regions, efficiency of the operation such as the deterioration inspection becomes undesirably low.

[0022]

As described above, in the conventional image display system,

for example, the usage case for, for example, the deterioration inspection support and the three-dimensional model generation of the structural object has difficulty and time and effort in selecting the individual image from the group of images. That is, the conventional system has problems in the support for and the efficient of the user's operation.

[0023]

Moreover, in view of the above-described problems or others, in the image display system according to the embodiment, a method capable of easily selecting the suitable image to support the user so as to reduce time and effort for the operation is provided when the user selects the individual image on the display screen from the group of images on depending its usage. The method includes a graphical user interface (GUI). The present image display system has a method of navigation and linkage to the next image in consideration of the overlap state among the images in selecting the next target image from a certain image of the group of images. The present image display system automatically determines an image (adjacent image) having, for example, the smallest degree of the overlap state, and provides a link image by which this image can be easily selected.

[0024]

In the image display system according to the embodiment, for example, data of the group of images obtained by fully photographing the entire surface region of the structural object so as to cause the partial overlap state is input. The group of images may include a plurality of images that are different in the photographing date and time, position, direction and other. The present image display system displays the list of the group of images on a GUI screen. When an individual image (first image) is selected by the user's operation from the screen, the present image display system displays the selected first image on the screen. The present image display

system determines a spatial positional relation between images (pair of the first image and a candidate image) for each of images (candidate images) spatially located on the periphery of the first image, and determines the overlap state in the photographing area among the images. In particular, the present image display system calculates the overlap state as an overlap rate. Moreover, the present image display system determines the spatial positional relation among the images by using the positional information of the image or others. On the basis of the overlap rate, the positional relation and others, the present image display system determines the image such as the adjacent image of the first image. For example, from the candidate images, the present image display system selects an image having the smallest overlap rate among the images within a range that is equal to or smaller than a predetermined overlap rate threshold value, as the adjacent image.

[0025]

The present image display system presents the image such as the adjacent image as an image (next image) serving as a candidate that is to be selected next as a target by the user. At this time, on the screen, the present image display system displays a link image indicating the presence of the next image and the positional relation with the first image. When the link image is selected and operated, the present image display system displays the next image (second image) associated with the link image as an individual image (new first image).

[0026]

By using the above-described image display system, the user can easily select the suitable image having the less overlap state from the certain image, so that the operation such as the deterioration inspection can be efficiently carried out. Regarding the spatial positional relation, the first image and the candidate image (adjacent image or others) may be different from each other

in a surface and a direction in which the photographing area is set. Even in this case, on the screen, the user can select the second image placed in a different direction from the first image and display the second image by an operation for the link image.

5 [0027]

(Embodiments)

Referring to FIG. 1 to FIGs. 27B, an image display system according to embodiments of the present invention will be described.

[0028]

10 [Structural-Object Deterioration Inspection Support System]

FIG. 1 shows an entire configuration of a structural-object deterioration inspection support system including an image display system of an embodiment. The image display system of the embodiment is constituted by a computer system 1. The structural-object
15 deterioration inspection support system of FIG. 1 includes the computer system 1 serving as an image display system, a drone 10 serving as a flight vehicle, and a structural object 5 serving as a target for the deterioration inspection or others. The computer system 1 and the drone 10 are connected to each other through wireless
20 communication. As the computer system 1, for example, a configuration including a client server system having a PC 2 and a server 3 is shown. The PC 2 and the server 3 are connected to each other through a communication network 6. A user (operator) utilizes the present system by operating the PC 2. On a GUI screen
25 22 of the PC 2, the user carries out an instruction input, user settings or others to the present system and can check the state and results of the operation or others.

[0029]

The structural-object deterioration inspection support
30 system of FIG. 1 has a deterioration inspection support function, and this deterioration inspection support function includes a three-dimensional model generating function. The deterioration

inspection support function is achieved by a deterioration inspection supporting software 100 or others. The deterioration inspection support function is a function for providing the GUI screen that supports the user's (operator's) operation for the deterioration inspection of the structural object 5. The deterioration inspection includes a visual inspection for a deterioration state of an image by the user's eye inspection, the image being photographed by a camera 4. The deterioration inspection may further include an automatic diagnosis carried out by the computer. The three-dimensional model generating function is a function for generating a three-dimensional model of the structural object 5 on the basis of the SFM process from the group of images of the camera 4 so as to provide a screen to be displayed. [0030]

The PC 2 is a computer having a drone controlling function 21 or others, and serves as a client terminal device used by each user (operator). The server 3 is a server device in, for example, a cloud computing system or a data center of a business operator or others, and carries out computing processes in cooperation with the PC 2. A plurality of PC 2 of a plurality of users or others may be similarly connected to the server 3. The PC 2 carries out flight control for the drone 10 and photographing control for the camera 4 by using wireless communication. The PC 2 transmits flight control information, photographing setting information or others to the drone 10.

[0031]

The structural object 5 is a target object for the deterioration inspection and the three-dimensional model generation, and serves as a subject to be photographed by the camera 4 of the drone 10. The structural object 5 is, for example, an architecture, an infrastructural facility or others. As the architecture, for example, a general building, house, public

architecture or others is cited. As the infrastructural facility, for example, electric power equipment, road traffic equipment, communication equipment, a bridge or others is cited. A predetermined region of a surface of the structural object 5 serves as the target region.

[0032]

The drone 10 is a flight vehicle that autonomously flies on the basis of remote control through wireless communication from the PC 2. The drone 10 autonomously flies along a set route in a peripheral space of the structural object 5. In the computer system 1, control information relating to the autonomous flight and the aerial photography of the drone 10 is previously generated and set as aerial-photography setting information so that the target region of the structural object 5 can be aurally photographed on the basis of photograph planning data "d2". The aerial-photography setting information contains the route of the flight of the drone 10, the photographing timing (photographing time and date), the photography setting information for the camera 4, and others.

[0033]

As a modified example, note that a mode in which the user navigates the flight of the drone 10 from the PC 2 or others may be applied.

[0034]

The camera 4 and various sensors or others are mounted on the drone 10. During the flight along the route, the drone 10 aurally photographs the structural object 5 by using the camera 4. The drone 10 transmits image data, sensor data or others at the time of the aerial photographing to the PC 2 through wireless communication. A publicly-known sensor group of the drone 10 can sense a position, a direction, a speed, an acceleration of the drone 10 or others as the sensor data. The position contains three-dimensional coordinate information that can be obtained in a format of, for

example, a latitude, a longitude, an altitude (height from the ground surface) or others on the basis of a GPS, an altitude sensor, or other position measuring system. When the GPS is used, note that a sufficient measuring accuracy is assumed.

5 [0035]

As the photography setting information, the camera 4 contains a camera direction (photographing direction), photographing timing, a photographing condition and others. The camera direction corresponds to a direction in which the camera is directed to a part
10 on the surface of the target object 5 with reference to the camera position. The photographing timing corresponds to a timing at which a plurality of continuous images (still images) are photographed, and is defined by a photographing interval or others. The photographing condition is defined by a publicly-known parameter
15 such as exposure or others.

[0036]

The PC 2 has a drone control function 21, a client program 20, a GUI screen 22 and others. The drone control function 21 is a function for controlling the flight of the drone 10 and the
20 photographing process of the camera 4. The client program 20 is a client program of the deterioration inspection supporting software 100. The client program 20 carries out a process in cooperation with the server program 30 through client-server communication. The client program 20 controls the drone control
25 function 21, the image display function, the GUI screen 22 and others. In a memory of the PC 2, various pieces of data and information to be used by the client program 20 or others for its process are stored. In the memory, control information of the drone 10, image data and sensor data acquired from the drone 10, various pieces of data
30 acquired from the server 3 and others are stored.

[0037]

The server 3 has a server program 30, a DB 31 and others. The

server program 30 is a server program of the deterioration inspection supporting software 100. In particular, the server program 30 takes charge of a process having a high computation load such as the deterioration inspection supporting program and the three-dimensional model generation process. In response to a request from the client program 20, the server program 30 executes a predetermined process, and replies the process result information.

[0038]

In the DB 31, various pieces of data and information to be used by the server program 30 and the client program 20 for their processes are stored. The DB 31 may be achieved by a DB server or others. In the DB 31, for example, structural object data d1, photographing planning data d2, image data d3, inspection data d4 or others are stored.

[0039]

The structural object data d1 contains basic information, managing information, design drawing data and three-dimensional data relating to the structural object 5 and others. In the present image display system, the three-dimensional data contains three-dimensional model data generated by the three-dimensional model generation function. The three-dimensional data is not limited to this, and data created by an existent three-dimensional CAD system or others can be utilized, if any.

[0040]

The photography planning data d2 is data for plans relating to the deterioration inspection and the aerial photographing. On the basis of the photography planning data, aerial-photography setting information taken by the use of the actual drone 10 is created and set. The image data d3 is data of the group of images photographed by the camera 4. The inspection data d4 is data indicating a state and a result of the deterioration inspection or

others.

[0041]

The mounting configuration of the computer system 1 may be achieved without being limited to the above-described example. For example, a mode in which the PC 2 and the server 3 are united as a single computer may be used, or another mode in which they are separated from each other among a plurality of devices for each of the functions may be used. Still another mode with a drone control device separated from the PC 2 may be used. Not the drone 10 but another flight vehicle, a robot or others may be similarly utilized. While a general-use drone can be utilized as the drone 10, a dedicated drone mounted with a dedicated function for the present image display system may be utilized.

[0042]

15 [Drone, Computer]

FIG. 2 shows a schematic configuration relating to the drone control function 21 in the drone 10 and the computer system 1. The drone 10 has a propeller driving unit 11, a flight control unit 12, a sensor 13, a gimbal 14, a camera 4, an image storage unit 15, a wireless communication unit 16, a battery 17 and others. The propeller drive unit 11 drives a plurality of propellers. The flight control unit 12 controls the flight of the drone 10 in accordance with the flight control information from the flight control unit 102 of the PC 2. For this reason, the flight control unit 12 controls the driving of the propeller driving unit 11 while using the information of the sensor 13. The sensor 13 is constituted by a group of sensors including a publicly-known GPS receiver, an electron compass, a gyroscope sensor, an acceleration sensor, and others, and outputs predetermined sensor data. The gimbal 14 is a publicly-known mechanism for holding the camera 4, which automatically maintains the camera 4 to be fixed without swaying during the flight. Each direction and each position of the drone

10, the gimbal 14 and the camera 4 are basically independent parameters.

[0043]

5 The camera 4 aerially photographs the target object 5 in accordance with the photographing control information and photography setting information from the photographing control unit 104 of the PC 2, and outputs the image data. The image storage unit 15 stores the image data or others. The wireless communication unit 16 includes a wireless communication interface device, and carries out wireless communications with the computer system 1 through a predetermined wireless communication interface. The battery 17 supplies power to each unit.

[0044]

15 The computer system 1 has a processor 111, a memory 112, a communication device 113, an input device 114, a display device 115 and others, which are connected to one another through a bus or others. The processor 111 executes processes in accordance with a program read by the memory 112. Thus, the respective functions of the deterioration detection support software 100 and the respective units of the GUI unit 101 or others can be achieved.

[0045]

25 The computer system 1 has the GUI unit 101, an aerial-photography setting unit 107, the flight control unit 102, the photographing control unit 104, a sensor data storage unit 103, the image data storage unit 105, the wireless communication unit 106, a deterioration inspection support unit 121, a three-dimensional model generation unit 122, an image display control unit 123 and others.

[0046]

30 The GUI unit 101 forms a GUI screen 22 for the user on the basis of an OS, a middle ware or an application program such as a Web browser, and allows a display device 114 (for example, a touch

panel) to display the screen. The user can operate a user setting and an instruction input onto the GUI screen 23 so that the state and the result of each of the functions or others can be checked. As the user setting, for example, it can be set whether each function of the present image display system is to be used or not, and a controlling threshold value for each function or others can be set. The GUI unit 101 generates screen data corresponding to the screens such as a list screen and an individual screen described later. [0047]

10 The aerial-photography setting unit 107 creates the aerial-photography setting information on the basis of the user operation and the photography planning data d2, and sets the resulting information onto the computer system 1 and the drone 10. The flight control unit 102 controls the flight of the drone 10 on the basis of the aerial-photography setting information. The flight control unit 102 transmits flight control information d101 to the drone 10 through wireless communications, and receives sensor data d102 indicating a flight state or others from the drone 10. The photographing control unit 104 controls the photographing process by using the camera 4 on the basis of the aerial-photography setting information. The photographing control unit 104 transmits photographing control information d103 to the drone 10 through wireless communication, and receives image data d104 or others from the drone 10.

25 [0048]

 The image data storage unit 105 stores the image data acquired from the drone 10. The photographing time and date, the sensor data, the photography setting information or others are appropriately associated with the image data so that the information is managed. 30 The wireless communication unit 106 includes a wireless communication interface device, and carries out wireless communication with the drone 10 through a predetermined wireless

communication interface.

[0049]

The deterioration inspection support unit 121 carries out a process corresponding to the deterioration inspection support
5 function. The deterioration inspection support unit 121 carries out, for example, a support process or an automatic diagnosis process for the visual inspection. The three-dimensional model generation unit 122 carries out a process corresponding to the three-dimensional model generation function. The image display
10 control unit 123 determines the spatial positional relation of the group of images, and controls image selection.

[0050]

[Image Display System]

FIG. 3 shows a configuration of an image display system
15 (computer system 1) of the embodiment. The image display system takes the group of images 201, the image information 202, the structural object data d1 and the photography planning data d2 on the basis of the image data d3 as inputs (including a storage or others). In the embodiment, the image data d3 as the input (group
20 of images 201) is mainly acquired by the camera 4 of the drone 10. However, the group of images is not limited to this, a group of images manually photographed by an operator may be used, or a combination of groups of images acquired by various means may be used. The group of images 201 is main body data of each image. The image information
25 202 is, for example, metadata or property information with a probably-known "Exif" format or others that is associated with each image. The image information 202 has information such as an ID (identification information), photographing time and date, a camera position, a camera direction, camera type and model, a focal distance,
30 a viewing angle, an image size (number of pixels) and others. Note that data generated by an SFM processing unit 122A are used as the camera position and the camera direction.

[0051]

The image display system has a list display unit 301, an individual display unit 302, an image display control unit 123, the deterioration inspection support unit 121, the three-dimensional
5 model generation unit 122 and others as processes (corresponding processing units). The image display control unit 123 includes an adjacent-image determination unit 303 and an overlap-rate calculation unit 304. The image display system outputs screens such as the list screen 401, the individual screen 402 or others as outputs
10 (including display, storage, or others).

[0052]

The list display unit 301 displays the list screen 401 on the basis of the group of images 201 and the image information 202 (such as the ID and the photographing time and date). On the list screen
15 401, a plurality of images of the group of images 201 are disposed and displayed in parallel with one another in an order on the basis of the ID or others.

[0053]

The individual display unit 302 displays the individual screen
20 402 on the basis of the group of images 201 and first image selection information 321 on the list screen 401. The individual display unit 302 displays a first image 322 selected by a user inside the individual screen 402. Moreover, the individual display unit 302 displays a second image 324 associated with the link image on the
25 basis of link image selection information 323 inside the individual screen 402.

[0054]

The image display control unit 123 recognizes the spatial positional relation among the images and an overlap degree by using
30 the adjacent-image determination unit 303 or others, and controls the linkage among the images and the selection for the next image.

[0055]

The adjacent-image determination unit 303 determines a candidate image, an adjacent image or others on the periphery of the first image on the basis of the image information 202 and the first image selection information 321 or the link image selection information 323 (that is, the second-image selection information). The adjacent image is an image that has the smallest overlap degree and that is adjacent. The adjacent-image determination unit 303 determines the positional relation among the images by using the positional information (camera position, etc.) and the direction information (camera direction, etc.) of the image information 202 in particular. Moreover, the adjacent-image determination unit 303 determines the adjacent image by using the information of the overlap rate calculated in the overlap-rate calculation unit 304. The adjacent-image determination unit 303 determines the distance between positions of a certain image (first image) and another image located on the periphery thereof, and also determines the difference in the direction (a corresponding camera direction, a direction of the plane on which the image photographing area is set, etc.) of each image.

[0056]

The overlap-rate calculation unit 304 calculates the overlap rate among the images on the basis of the first-image selection information 321, candidate image information obtained by the determination of the adjacent-image determination unit 303, etc.

[0057]

Inside an individual screen 402, the image display control unit 123 displays a link image 325 corresponding to an image such as the adjacent image determined by the adjacent-image determination unit 303. The link image 325 is a link image (GUI part) for use in navigating the image (next image) to be a candidate that is selected next to the first image.

[0058]

The deterioration inspection support unit 121 carries out a support process for the visual inspection or others on the basis of the user's operation while using the individual screen 402 as a deterioration inspection screen, displays the state and results of the process on the deterioration inspection screen, and forms and stores inspection data d4 indicating the state and results of the process.

[0059]

The three-dimensional model generation unit 122 includes an SFM process unit 122A. The SFM process unit 122A receives the group of images 201 as its input and carries out an SFM process, so that a three-dimensional model of the structural object 5 and the information of the camera direction and the camera position are generated, and the corresponding three-dimensional model data d5 is created. On the basis of the three-dimensional model data d5, the three-dimensional model generation unit 122 displays a structural-object three-dimensional model screen. The three-dimensional model generation unit 122 writes the obtained information of the camera direction and the camera position to the image information 202 or manages and controls the information in association with the image data d3.

[0060]

The user carries out an operation (first-image selection operation) OP1 for selecting a desired image from the group of images as a first image onto the list screen 401. Moreover, the user carries out an operation (second-image selection operation = link-image selection operation) OP2 for selecting a link image onto the individual screen 402. Furthermore, the user carries out a deterioration inspecting operation OP3 onto the image of the individual screen 402 (deterioration inspection screen).

[0061]

[Process Flow]

FIG. 4 shows a process flow of the structural-object deterioration inspection support system including the image display system of the embodiment. The flow of FIG. 4 includes steps S1 to S13. The process flow will be described in an order of the steps.

5 [0062]

(S1) On the basis of a user's operation and the photography planning data d2 or others of the structural object 5, the computer system 1 forms and sets aerial-photography setting information of the drone 10. On the basis of the aerial-photography setting information, an aerial photographing process by the drone 10 is executed. By the aerial photographing process, image data or others photographed by the camera 4 is transmitted to the PC 2. The PC 2 transmits the image data or others to a server 3. The server 3 stores the image data d3 or others in a DB 31.

15 [0063]

(S2) The computer system 1 reads the image data d3 (image data 201, image information 202) from the DB 31 or others, and holds the data in a processing memory.

[0064]

20 (S3) The computer system 1 (in particular, list display unit 301) displays a list of the group of images on the list screen 401 (FIG. 14) on the basis of the image data d3 (group of images 201, image information 202).

[0065]

25 (S4) The computer system 1 receives a user's operation on the list screen 401. When the computer system receives a predetermined operation (first-image selection operation OP1), it obtains the first-image selection information 321, and selects a first image. The first-image selection operation OP1 is to, for example, click
30 one image, tap the same, or others.

[0066]

(S5) On the basis of the operation of S4 and the first-image

selection information 321, the computer system 1 (in particular, individual display unit 302) displays the selected first image 322 on the individual screen 402 (FIG. 15). The user can carry out deterioration inspecting operation while using the individual screen 402 as a deterioration inspection screen (FIG. 21).

[0067]

(S6) On the basis of the image information 202 and the first-image selection information 321 (or link-image selection information 323), the computer system 1 (in particular, adjacent-image determination unit 303) searches each image (candidate image) located on the periphery of the first image. At this time, the adjacent-image determination unit 303 determines the positional relation between images by using the information such as the camera position and the camera direction of the image or others.

In particular, the adjacent-image determination unit 303 calculates the distance in the position between the first image and the candidate image, and picks up the candidate image relative to the first image on the basis of the distance. At this time, the adjacent-image determination unit 303 picks up the candidate images in an ascending order of the distance. Moreover, at this time, the adjacent-image determination unit 303 narrows down the candidate images within a range of a distance threshold value in the distance by using the predetermined distance threshold value. At this stage, note that the adjacent image has not been determined yet.

[0068]

Moreover, in particular, in the present processing example, when the candidate image is picked up, the adjacent-image determination unit 303 first previously picks up images substantially having the same camera direction such as images disposed inside the same plane, as the candidate images.

[0069]

(S7) The computer system 1 (in particular, overlap-rate

calculation unit 304) sequentially calculates the overlap rate (referred to as OL) between images that are a pair of the first image and each candidate image for each of the candidate images obtained in S6. At this time, as described later, the overlap-rate calculation unit 304 calculates a photographing area for each of the images (FIG. 7), and calculates the overlap rate OL by using the photographing area or others (FIG. 12 and others).

[0070]

(S8) The computer system 1 (in particular, adjacent-image determination unit 303) determines an overlap state by comparing the overlap rate OL obtained in S7 with a predetermined overlap rate threshold value (referred to as TOL) that has been previously set. In the present processing example, the adjacent-image determination unit 303 determines whether or not the OL value relating to the candidate image is the smallest within a range that is larger than 0 but equal to or smaller than the TOL value. The computer system 1 selects such a candidate image as to satisfy the above-described conditions as the adjacent image (adjacent image having the smallest overlap state). The computer system 1 similarly determines the adjacent image in each of upside, downside, right-side and left-side directions inside the plane.

[0071]

Note that the overlap rate threshold value TOL has been previously set in the program of the deterioration inspection support software 100. The TOL value may be set by the user without limiting to the above.

[0072]

(S9) The computer system 1 checks whether or not such an adjacent image as to satisfy the overlap state condition has been found in the results in S8. If it has been found (Y), the sequence proceeds to S11. If it has not been found (N), the sequence proceeds to S10. The case described here in which it has not been found

corresponds to a case in which the adjacent image has not been found from images substantially having the same camera direction of images as one another, such as images disposed inside the same plane.
[0073]

5 (S10) In S10, except for the searched images, the computer system 1 selects a candidate image having the smallest distance in the position between the images as the next image. As described later, for example, the next image corresponds to an image having a different camera direction and being disposed on a different plane
10 (side surface or others) from the first image. Alternatively, the next image corresponds to an image being far from but in the same plane as the first image without the overlap.
[0074]

 (S11) Inside the individual screen 402, the computer system
15 1 (image display control unit 123) displays a link image 325 (link image 403 of FIG. 15, link image 404 of FIG. 16, etc.) relating to the image (next image) selected in S8 or S10. In particular, the image display control unit 123 displays the link image 325 in accordance with a type of the next image in each direction relative
20 to the first image.
[0075]

 (S12) The computer system 1 receives a user's predetermined operation (second-image selection operation OP2) for the link image 325 on the individual screen 402. The second-image selection
25 operation OP2 is to click the link image, tap the same, or others. Moreover, on the individual screen 402, the computer system 1 receives another operation such as an operation for use in returning to the list screen 401 and a finishing operation. When the computer system 1 receives (Y) a selection operation (second-image selection
30 operation OP2) for the link image 325, the sequence proceeds to S13. When it receives the operation for use in returning to the list screen 401, the sequence returns to S3.

[0076]

(S13) In S13, on the basis of the link-image selection information (second-image selection information) 324 in S12, the computer system 1 (in particular, individual display unit 302) displays the next image (second image) indicated by the selected link image 325 as a new first image on the individual screen 402. After step S13, the sequence returns to S6, and the same repeated processes are carried out. The user can carry out the deterioration inspecting operation on the individual screen 402 (deterioration inspection screen) while viewing the new first image. Thereafter, similarly, selection and display transition from certain image to another image in the group of images can be carried out.

[0077]

[Aerial Photographing System (1)]

Each of FIGs. 5A and 5B shows a first example of an aerial photographing system for the structural object 5 by the use of the drone 10. The aerial photographing system is not limited to this. As the aerial photographing system, a suitable system is selected in consideration of the process and the characteristics of the image display system. By using the drone control function 21 of the computer system 1, the route of the aerial photographing process by the drone 10, photographing settings for the camera 4 or others can be set as aerial-photography setting information on the basis of the photography planning data d2 or others. The aerial-photography setting information is held in the DB 31 or others.

[0078]

FIG. 5A shows an overhead view configuration in a Z-direction in a case of the structural object 5 that schematically has a rectangular parallelepiped body. The structural object 5 has four side surfaces A1 to A4 that stand vertically. In the present image display system, for example, the entire surface regions of the side

surfaces A1 to A4 are fully photographed as the deterioration inspection targets. Moreover, the structural object 5 has, for example, corner parts at which side surfaces in different directions from each other are connected to each other as shown by a corner part 501.

[0079]

In the present example, the side surfaces of the target object 5 are photographed so as to form groups (side surface groups), respectively. In the present example, four groups are formed so as to correspond to the four side surfaces A1 to A4, and four routes R1 to R4 are correspondingly set, so that the aerial photographing processes are separately executed four times. In the present example, the route for each group is basically a linear route (indicated by an arrows with a broken line), and is controlled so that the camera direction (indicated by a one-dot chain line) and a target distance D0 are substantially constant.

[0080]

For example, first, the group of the side surface A1 is aerially photographed on the route R1. In the route R1, the camera direction is set to the Y-direction (direction Y1 from the front side toward the rear side). Next, the group of the side surface A2 is aerially photographed on the route R2. In the route R2, the camera direction is set to the X-direction (direction X1 from the right side toward the left side). The same goes for the route R3 of the side surface A3 and the route R4 of the side surface A4.

[0081]

FIG. 5B shows the structural object 5 and the routes of the aerial photographing processes as a perspective view so as to correspond to FIG. 5A. In particular, a detailed set example on the route R1 on which the group of side surface A1 is aerially photographed is shown. In the present example, in the full photographing of the entire regions of side surface A1 (X-Z plane),

a system that is the same as a so-called line sequential scanning system is used. In this system, first, the drone 10 is linearly moved as a main scanning process from one end to the other end of the side surface A1 in the X-direction corresponding to the horizontal direction. In the movement in the horizontal direction, the direction of the camera 4 and the target distance D0 are controlled so as to be set substantially constant. After the drone 10 has reached the other end of the side surface A1, the drone 10 is next linearly moved as the sub scanning process in the vertical direction (Z-direction). Next, similarly, it is linearly moved as the main scanning process from the other end to the one end of the side surface A1 so as to return in an opposite direction in the X-direction. Thereafter, the main scanning and the sub scanning processes are similarly repeated.

15 [0082]

In the example of the present embodiment, note that the side surface that vertically stands has been mainly described as the target. However, a horizontal surface such as a rooftop of the structural object 5 can be similarly processed as the target. In this case, the direction of the camera 4 at the time of the aerial photographing is, for example, set to a downside direction in the Z-direction. Moreover, in the example of the embodiment, as the direction of the camera 4 at the time of aerial photographing, a case of the X-direction and the Y-direction that are horizontal directions in a plan view of the side surface has been described. However, the direction is not limited to this, even in a case of, for example, an oblique downside direction or others, the same process may be carried out.

[0083]

30 At the time of setting the aerial photographing process, in consideration of the SFM process of the three-dimensional model generation function, the route of the drone 10, the photographing

timing (interval) of the camera 4 and others are set so that the overlap state between the images is suitable. For example, they are set so that the overlap state in the proceeding direction of the drone 10 and the camera 4 is about 80%. Under the aerial
5 photographing process on the basis of this setting, a group of images having the suitable overlap state can be obtained. By using this group of images as the input, The SFM process can be reliably carried out, so that a three-dimensional model with high accuracy can be obtained.

10 [0084]

 However, when the group of images handled for the usage of the above-described three-dimensional model generation is also used for the deterioration inspection, there are many overlap regions between the images. Therefore, in the deterioration inspection for
15 each of the images, there are many inspected regions (that is, overlap regions), and there are many regions to be inspected again, which result in inefficiency. For this reason, in order to efficiently carry out the deterioration inspection process, it is preferable to select a group of images having the overlap between
20 images that is as small as possible from the groups of images, as the group of images serving as the deterioration inspection target. However, it is difficult to manually carry out this image selection, and long time and large effort are required. Therefore, the present image display system provides a method such as GUI which can support
25 the image selection and make it efficient.

[0085]

[Aerial Photographing System (2)]

 Each of FIGs. 6A and 6B similarly shows a second example of the aerial photographing system for the structural object 5 by the
30 use of the drone 10. Depending on the shape of the structural object 5 or others, such aerial photographing systems are suitably selected. In the present example, the structural object 5 of FIG. 6A has such

a shape as to additionally connect another rectangular parallelepiped body to a front side (Y-2 direction) of a part of the right side (X-2 direction) of the side surface A1 of the structural object 5 having the rectangular parallelepiped body of FIGs. 5A and 5B. It is assumed that this structural object 5 has six side surfaces a1 to a6 so that all the entire surface regions of them are the inspection targets. Moreover, the structural object 5 has corner portions such as a corner portion 601, a corner portion 602, a corner portion 603 and others. The corner portion 601 is a portion at which the side surface a1 extending in the X-direction and the side surface a2 extending in the Y-direction are connected to each other, and is a concave corner portion when viewed from the drone 10. The corner portion 602 is a portion at which the side surface a2 extending in the Y-direction and the side surface a3 extending in the X-direction are connected to each other, and is a convex corner portion when viewed from the drone 10. The corner portion 603 is a portion at which the side surface a3 extending in the X-direction and the side surface a4 extending in the Y-direction are connected to each other, and is a convex corner portion.

[0086]

In the present example, similarly, the side surfaces of the target object 5 are photographed so as to form groups, respectively. In the present example, six groups are formed so as to correspond to the six side surfaces a1 to a6, and six routes r1 to r6 are correspondingly set, so that the aerial photographing processes are separately executed six times. The route for each group is a linear route, and is controlled so that the camera direction and the target distance D0 are substantially constant. As a whole, the camera directions are classified into four types of a direction Y1, a direction Y2, a direction X1 and a direction X2. For example, in the route r1 of the group of the side surface a1, the camera direction corresponds to the Y-direction (direction Y1). In the route r2 of

the group of the side surface a2, the camera direction corresponds to the X-direction (direction X2). In the route r3 of the group of the side surface a3, the camera direction corresponds to the Y-direction (direction Y1). In the route r4 of the group of the side surface a4, the camera direction corresponds to the X-direction (direction X1). The same goes for a route of another side surface. [0087]

FIG. 6B shows the structural object 5 and the route of aerial photographing as a perspective view so as to correspond to FIG. 6A. In particular, a detailed set example on the route r1 for the side surface a1 and the route r3 for the side surface a3 is shown. As similar to FIG. 5B, a system that is the same as a so-called line sequential scanning system is used for each side surface. [0088]

[Photographing Area]

FIG. 7 is a schematic view relating to an image photographing area or others. The image display control unit 123 of the image display system calculates the image photographing area as follows. The image photographing area is used for calculations of the overlap rate. The photographing area is a size in an actual world, which is defined by longitudinal and lateral lengths of the image or others. In order to calculate the photographing area, a focal distance (referred to as "F"), a sensor size (referred to as "SS"), a target distance (referred to as "D") and others are used. In an overhead view in the Z-direction, FIG. 7 shows a wall surface 701 (for example, side surface A1) of the structural object 5, a proceeding direction K1 (for example, X-direction) in a part of an aerial photographing route of the drone 10, a position of the camera 4 (referred to as camera position "C"), a direction of the camera 4 (referred to as camera direction "V"), a sensor 702 of the camera 4, an image photographing area (referred to as "SA" particularly indicating a width in the X-direction), etc.

[0089]

The sensor 702 is a photographing element for the camera 4, and is shown as the width in the X-direction in FIG. 7. The sensor 702 has a predetermined sensor size SS (in particular, indicating the width in the X-direction). The sensor size SS depends on a camera type and model, and is defined by a width, a height, a diagonal distance and others. The sensor size SS may be contained in the image information 202. Alternatively, even if it is not contained, the sensor size can be recognized from the camera type and model or another information. A center position of the sensor 702 is shown as a camera position C. The camera direction V (indicated by a one-dot chain line) exists in, for example, the Y-direction from the sensor 702 and the camera position C. A position at which the camera direction V intersects with the wall surface 701 is shown as a position "Q". The position Q corresponds to the center position of the image and the photographing area SA. A distance from the camera position C to the position Q of the wall surface 701 (side surface A1) in the camera direction V includes the focal distance F and the target distance D. The focal distance F is obtained from the image information 202. The target distance D is a distance to the target object. The target distance D is obtained on the basis of the photography planning data d2. The target distance D is obtained from, for example, a target distance D0 of FIG. 5A.

[0090]

The computer system 1 (in particular, the overlap-rate calculation unit 304) calculates the photographing area SA by using the sensor size SS, the focal distance F, the target distance D and others. A basic calculation formula is "[Photographing area SA] = [Sensor size SS] ÷ [Focal distance F] × [Target distance D]". A specific example is as follows. As the sensor size being set to SS, it is assumed that a lateral (width) length is 23.5 mm and a longitudinal (height) length is 15.6 mm. It is assumed that the

focal distance F is 35 mm. It is assumed that the target distance D is 5 m (= 5000 mm). In the photographing area SA , when it is assumed that the width in the lateral direction (X -direction) is " SAX " and that the height in the longitudinal direction (Z -direction) is " SAZ ",
5 the photographing area SA can be calculated so that " $SAX = (23.5/35) \times 5000 \approx 3357$ mm" and " $SAZ = (15.6/35) \times 5000 \approx 2229$ mm".
[0091]

The computer system 1 similarly calculates the photographing area SA of each image of the group of images. The computer system
10 1 (overlap-rate calculation unit 304) calculates the overlap rate between the images by using the photographing area SA of each image or others. Moreover, the computer system 1 (adjacent-image determination unit 303) determines the positional relation between the images by using information such as the camera position C , the
15 camera direction V , and the photographing area SA .
[0092]

[Camera Position and Camera Direction]

The computer system 1 uses the information such as the camera position C and the camera direction V for its process. The
20 information such as the camera position C and the camera direction V can be obtained by, for example, the following methods.
[0093]

(1) When information of the camera position C and the camera direction V are contained in the image information 202 or in the
25 sensor data at the time of the aerial photographing, the computer system 1 refers to the information of the camera position C and the camera direction V . For example, the camera 4 itself may include a sensor capable of detecting the camera position C and the camera direction V . In this case, the information of the detected camera
30 position C and camera direction V is associated with the image data of the image photographed by the camera 4, so that the information can be referred to.

[0094]

(2) When the information of the camera position C and the camera direction V is not contained in the image information 202, the computer system 1 calculates the camera position C and the camera direction V from other information. For example, the computer system 1 obtains pieces of information such as the position and the direction of the drone 10 as well as a position and a direction of a gimbal 14 on the basis of the sensor data at the time of aerial photographing. The computer system 1 obtains the camera position C and the camera direction V through calculations by using those pieces of information. The camera position C or others can be calculated by combining a relative positional relation of the gimbal 14 mounted on the drone 10 with a relative positional relation of the camera 4 mounted on the gimbal 14.

[0095]

(3) The computer system 1 obtains the camera position C and the camera direction V from the group of images (for example, continuous three images) by carrying out the SFM process. In the image display system of the present embodiment, this system is used. By carrying out the SFM process to the input group of images, the SFM process unit 122A of the three-dimensional model generation unit 122 obtains the camera position C and the camera direction V.

[0096]

[Overlap between Images (1)]

FIG. 8 shows the overlaps between the images and between the photographing areas in an aerial-photography proceeding direction. FIG. 8 shows a part of a route for the wall surface 701 as an overhead view in the Z-direction. The proceeding direction K1 of the drone 10 at the time of aerial photographing is, for example, a main scanning direction X2 in the route R1 of FIGs. 5A and 5B or a main scanning direction X2 in the route r1 of FIGs. 6A and 6B. The camera direction C is the direction Y1. In the proceeding direction K1,

positions P1 to P7 are shown with dots as examples of a position "P" of the drone 10. Correspondingly, positions C1 to C7 are shown with dots as examples of the camera position C. The target distance D0 at each position is constant. The positions P1 to P7 and the positions C1 to C7 have an order in the time sequence. Moreover, the center positions on the side of the image and the photographing area are shown with dots as positions Q1 to Q7 so as to correspond to the positions C1 to C7 or others. For example, images g1 to g7 and photographing areas SA1 to SA7 are provided. In this case, the photographing area indicates the width in the X-direction. For example, the photographing area SA on the image g1 photographed at the position P1 and the position C1 is a photographing area SA1, and the center position is a position Q1. The example of FIG. 8 shows a case in the photographing areas SA1 to SA7 on the images g1 to g7 with the overlap of about 80% between the respective images in the proceeding direction K1.

[0097]

[Overlap between Images (2)]

FIG. 9 shows the overlap between the images in a plan view (X-Z plane such as the side surface A1) so as to correspond to the example of FIG. 8. FIG. 9 illustrates a case of the images g1 to g7 with slight shift even in the Z-direction (proceeding side direction K2) in order to easily understand the overlap state. A proceeding direction K1 indicates a case of the direction X2 as similar to that of FIG. 8, and a proceeding side direction K2 is a vertical direction perpendicular to the proceeding direction K1. A proceeding direction K3 is a direction obtained in a case obtained by adding shift (moving component) in the proceeding side direction K2 to the proceeding direction K1. In the present example, an overlap region 901 shown with a diagonal line pattern indicates an overlap region between a pair of the image g1 (photographing area SA1) and the image g2 (photographing area SA2). An overlap region

902 indicates an overlap region between a pair of the image g1 and the image g6 (photographing area SA6).

[0098]

In the present example, the image g1 to the image g7 belong
5 to a group of images that have been photographed so as to ensure an overlap rate (for example, about 80%) required for generating a three-dimensional model. For example, a pair of the image g1 and the next image g2 has an overlap rate OL of 80% or more (for example, 85%). Similarly, the overlap rate OL relative to the image g1 is
10 65% for the image g3, 45% for the image g4, 25% for the image g5 and 5% for the image g6. In a pair of the image g1 and the image g7, there is no overlap, and a clearance exists therebetween.

[0099]

It is assumed that the overlap rate threshold value TOL set
15 for the deterioration inspection is, for example, 20%. In consideration of each of the candidate images (images g2 to g7, etc.) on the right side (in the direction X1) relative to the image g1, the image g6 is selected as such an image as to satisfy the conditions of the above-described overlap rate (FIG. 4, S8). The overlap rate
20 OL (= 5%) of the image g6 relative to the image g1 is the smallest within a range that is larger than 0 but equal to or smaller than the overlap rate threshold value TOL (= 20%).

[0100]

Note that not only the overlap rate in the proceeding direction
25 K1 (the X-direction, the lateral direction of the image) but also the overlap rate in the proceeding side direction K2 (the longitudinal direction of the image) may be also considered. In the present image display system, also for the proceeding side direction K2, the same process is carried out by using a
30 predetermined overlap rate threshold value.

[0101]

[Overlap between Images (3)]

FIG. 10 shows an example of the adjacent images in a plan view (the X-Z plane such as the side surface A1) so as to correspond to the example of FIG. 9. It is assumed that the first image selected by the user is, for example, the image g1. As the candidate image, the present image display system searches each of images that are located on the periphery of the image g1 in a three-dimensional space. In the example of FIG. 10, in the right-side direction (direction X2) relative to the image g1, there are the images g2 to g7 and others as similar to those in FIG. 9. Regarding the right-side direction relative to the image g1, the image g6 is selected as the image (adjacent image) having the smallest overlap as shown in FIG. 9. The image g6 that is the adjacent image in the right-side direction is also shown as an image "ga". A position "Qa" of the image ga is the position Q6 of the image g6. In the image display system, a link image showing the image ga is displayed on the individual screen 402.

[0102]

In the left-side direction (direction X1) relative to the image g1, for example, an image "gb" (position "Qb") is cited as the adjacent image. Each image between the image g1 to the image gb is omitted. Similarly, in the upside direction (direction Z1) relative to the image g1, for example, an image "gc" (position "Qc") is cited as the adjacent image. In the downside direction (direction Z2) relative to the image g1, for example, an image "gd" (position "Qd") is cited as the adjacent image. Similarly, in a diagonally down right-side direction relative to the image g1, for example, an image "ge" (position "Qe") is cited as the adjacent image. There are the adjacent images also in a diagonally up right-side direction relative to the image g1, a diagonally up left-side direction thereto, and a diagonally down left-side direction thereto although not illustrated. On the individual screen 402, the user can select a desired next image (second image) from the link images

(corresponding adjacent images) displayed in the respective directions relative to the first image.

[0103]

Moreover, in the present image display system, in determining
5 an image located in a diagonal direction relative to a certain first
image (for example, the image g_1), for example, determining the
diagonally down right-side image g_e at the position Q_e , the following
systems may be used. As a first system, the adjacent image is
determined by directly searching an image located in a diagonal
10 direction relative to the image g_1 at the position Q_1 , calculating
the overlap rate between the image g_1 and the image located in the
diagonal direction, and using a predetermined overlap rate
threshold value (set for the diagonal direction). As a different
second system, the right, left, upside, and downside adjacent images
15 relative to the image g_1 at the position Q_1 may be determined first,
and then, another right, left, upside, and downside adjacent images
relative to the obtained adjacent images (for example, the image
 g_a , the image g_d) in the determination may be further determined.
In other words, the adjacent images in the diagonal directions may
20 be obtained on the basis of the results of the similar determinations
in two directions on two steps from the first image.

[0104]

[Calculation of Overlap Rate (1)]

With reference to FIGs. 11 and 12, the calculation of the
25 overlap rate will be described. A basic definition of the overlap
rate is explained below. Ideally, the overlap state in the surface
region (corresponding photographing area SA) of the structural
object 5 is considered. In the computer system 1, an overlap region
between images is considered in a surface region on an image on which
30 the position Q of FIG. 7 is the center position. The computer system
1 calculates the sizes of the image and the overlap region. A rate
indicating the overlap degree of the overlap region between the

images is defined as the overlap rate. The computer system 1 calculates the overlap rate on the basis of the sizes of the image and the overlap region. When a distance (target distance D_0) between the camera 4 and the surface of the structural object 5 in the photographing is set constant, the size of the region photographed in each of images almost corresponds to a size of an object in the actual world. Therefore, in this case, when the overlap rate is calculated by using the size of the image region, sufficient effects can be obtained.

10 [0105]

First, FIG. 11 shows an overlap state in the photographing area SA of two images. FIG. 11 is illustrated as an overhead view in the Z-direction. When the side surface A1, etc., is taken as the target, an image G1 photographed from a camera position C1 and an image G2 photographed from a camera position C2 are shown. A position Q1 of the image G1 and a position Q2 of the image G2 are shown. Each of the position C1 and the position Q1, etc., has three-dimensional positional coordinates. A width W1 in the X-direction in the photographing area SA of the image G1 and a width W2 in the X-direction in the photographing area SA of the image G2 are shown. The width of the overlap region in a pair of the image G1 and the image G2 is shown by a width W12. For example, the overlap rate in the X-direction between the image G1 and the image G2 can be calculated by using the width W1 of the image G1 and the width W12 of the overlap region.

25 W12 of the overlap region.

[0106]

Since the drone 10 sways because of catching the wind or others during the flight on its route, note that the position of the drone 10, the position of the camera 4, the camera direction, etc., may sway and be shifted. That is, the camera directions C of the respective images are different from one another in some cases. Even in this case, the photographing area SA and the overlap rate of the

30

image on the surface of the structural object 5 can be similarly calculated.

[0107]

[Calculation of Overlap rate (2)]

5 FIG. 12 shows an overlap state in an image in a plan view (X-Z plane) so as to correspond to FIG. 11. Moreover, the present example describes a case in which the image size is different between the image G1 at the position Q1 and the image G2 at the position Q2. An overlap region 1201 (diagonal line pattern) in an image pair
10 between the image G1 at the position Q1 and the image G2 at the position Q2 is shown. The image G1 has the width W1 as the width W in the X-direction and the height H1 as the height H in the Z-direction. The image G2 has the width W2 and the height H2. In a pair between the image G1 and the image G2, a width W12 in the
15 overlap region 1201 and a height H12 in the overlap region 1201 are shown. A width NW1 and a height NH1 of a non-overlap portion of the image G1 and a width NW2 and a height NH2 in the non-overlap portion of the image G2 are also shown.

[0108]

20 In this case, as the overlap rate OL, an overlap rate (referred to as OLW) in the lateral direction (X-direction) of the image and an overlap rate (referred to as OLH) in the longitudinal direction (Z-direction) of the image are considered. The overlap rate OL can be defined by a ratio of the length of the overlap portion relative
25 to the original length in the first image. In the present example, the overlap rate OLW in the lateral direction (X-direction) can be calculated as " $OLW = W12/W1$ ", and the overlap rate OLH in the longitudinal direction (Z-direction) can be calculated as " $OLH = H12/H1$ ". Note that the three-dimensional positional coordinates
30 (X, Y, Z) are processed so as to be suitably converted into two-dimensional coordinates (x, y) in the process of the two-dimensional image.

[0109]

In the example of FIG. 12, it is assumed that the coordinates of the position Q1 of the image G1 are set to (X1, Y1, Z1) and the coordinates of the position Q2 of the image G2 are set to (X2, Y2, Z2). It is assumed that the position on the left end in the X-direction in the photographing area SA of the image G1 is X3 and the position on the right end therein is X4. It is assumed that the position on the left end in the X-direction in the photographing area SA of the image G2 is X5 and the position on the right end therein is X6. It is assumed that the position on the upper end in the Z-direction in the photographing area SA of the image G1 is Z3 and the position on the lower end therein is Z4. It is assumed that the position on the upper end in the Z-direction in the photographing area SA of the image G2 is Z5 and the position on the lower end therein is Z6. In the present example, the position in the Y-direction is the same.

[0110]

The position of each end (side) on the upside, downside, right-side and left-side directions of the image G1 can be obtained as follows by using the center position Q1, the width W1 and the height H1. The position X3 on the left end of the image G1 is obtained as " $X3 = X1 - (W1/2)$ ". The position X4 on the right end of the image G1 is obtained as " $X4 = X1 + (W1/2)$ ". The position Z3 on the upper end of the image G1 is obtained as " $Z3 = Z1 - (H1/2)$ ". The position Z4 on the lower end of the image G1 is obtained as " $Z4 = Z1 + (H1/2)$ ". Similarly, the positions (X5, X6, Z5, Z6) of the respective ends of the image G2 can be obtained. By using the positions of the respective ends of each image, the width W12 and the height H12 of the overlap region 1201 and others can be calculated. For example, calculations are as " $W12 = X4 - X5$ " and " $H12 = Z5 - Z4$ ".

[0111]

Specific examples of calculations are as follows. It is

assumed that the size (represented by the number of pixels) of the image G1 is expressed as "W1 = 339" and "H1 = 252" and that the size of the image G2 is expressed as "W2 = 373" and "H2 = 244". It is assumed that coordinates (X1, Z1) of the position Q1 are (1420, 2395) and that coordinates (X2, Z2) of the position Q2 are (1510, 2376). As coordinates of the respective image ends, it is assumed that "X3 = 1251", "X4 = 1589", "X5 = 1324", "X6 = 1696", "Z3 = 2520", "Z4 = 2269", "Z5 = 2497" and "Z6 = 2254". By using these pieces of information, the width W12 and the height H12 of the overlap region 1201 are obtained as "W12 = 265" and "H12 = 228". The overlap rate OLW in the lateral direction is expressed as "OLW = 265/339 $\approx$ 0.78", that is, 78%. The overlap rate OLH in the longitudinal direction is expressed as "OLH = 228/252 $\approx$ 0.90", that is, 90%.

[0112]

The overlap rate may be processed by not only the above-described system but also, for example, the following system. A state of an object in the surface region represented by colors of pixels, characteristic points thereof or others in the image contents photographed in the image is considered. By using a publicly-known image process, the characteristic points, color regions or others can be extracted from the image. The computer system 1 determines the position of the same object (represented by characteristic points or others) inside each of the images, and determines an overlap region between the images on the basis of the position of the same object. The computer system 1 calculates the overlap rate from the size (represented by the number of pixels) of the overlap region.

[0113]

[SFM process]

FIG. 13 shows an explanatory diagram about a publicly-known SFM. The SFM is a system of obtaining the three-dimensional coordinates of the target object and the information (camera

parameters) of the camera direction and the camera position by using a plurality of images obtained by photographing the same object (represented by a plurality of characteristic points) from a plurality of viewing points (camera positions). For example, by using three images photographed from three camera positions, the information can be obtained. In the SFM, by utilizing a disparity on the basis of the movements of the cameras, the three-dimensional coordinates are estimated and calculated on the basis of how much amount the same characteristic point of the target object has shifted. The calculated three-dimensional coordinates represent a structure and a shape of the target object. The example of FIG. 13 shows continuously-photographed three images PIC1 to PIC3 of a (for example, cube) target object OB. As examples of the characteristic points of the target object OB, characteristic points A and B are shown. In the SFM process taking the images PIC1 to PIC3 as inputs, a group of characteristic points (for example, characteristic points A and B) are extracted from each of the images, and three-dimensional coordinates of the group of the characteristic points are obtained by a factorization method or others. For example, the coordinates (Xa, Ya, Za) of the characteristic point A and the coordinates (Xb, Yb, Zb) of the characteristic point B can be obtained. In addition to these, the camera directions (for example, directions J1 to J3) and the camera positions (for example, positions E1 to E3) are estimated. To the three-dimensional model generation function for the structural object, note that various applied systems on the basis of the SFM system or another system may be similarly applied.

[0114]

[List Screen (1)]

FIG. 14 shows a first example of a list screen 401 in the present embodiment. In the list screen 401, a list of a group of images is displayed. In the present example, in an order in which

the ID or the photographing time and date in the image information 202 is used, a plurality of images (for example, indicated by #1 to #24, etc.) of the group of images 201 are arranged and displayed longitudinally as well as laterally in parallel with one another in a thumbnail format. The group of these images is a group of images that have been photographed in consideration of, for example, a predetermined overlap rate for generating a three-dimensional model. As another display example, not only the thumbnail images but also the image information 201 may be displayed for each of the images.

10 [0115]

[Individual Screen (1)]

FIG. 15 shows a first example of the individual screen 402. In the individual screen 402, a first image selected by the user from the list screen 401 is displayed in a frame 1501 of a sufficiently large main region. Moreover, also when a second image is selected by selection of the link image on the individual screen 402, the second image is displayed in the frame 1501. Note that the sequence can return to the list screen 401 by carrying out a predetermined operation such as pushing of a "Return to List" button 1502 inside the individual screen 402.

20 [0116]

Inside the individual screen 402, a link image 403 is displayed on the periphery of the first image. In other words, the link image 403 corresponds to a navigation image. In the example of FIG. 15, on the outside of the first image (frame 1501), the link image 403 is displayed at each of upside, downside, right-side and left-side positions and each of diagonally (up right, down right, up left and down left side) positions. This example shows that the link image 403 has an arrow shape. However, the link image is not limited to this, and a GUI part having a predetermined shape, an icon image, or others may be applicable. As another example of the link image 403, a thumbnail image may be applicable.

[0117]

These link images 403 are images or parts for use in selecting the adjacent image in a direction indicated by the arrow as the next image. These link images 403 are images or parts for use in selecting the adjacent image inside a certain plane. The user can carry out the operation (tapping or others) for selecting the link image 403.

[0118]

In the GUI example of FIG. 15, all of these link images 403 are displayed in the respective directions regardless of the presence or absence of actual adjacent images in the respective directions. The user selects and operates a desired link image 403 (for example, a right arrow). In this case, when the adjacent image is present in the direction indicated by the selected link image 403, this adjacent image is selected as the second image. That is, the screen display state is transited so as to display the selected second image in place of the first image inside the frame 1501 of the individual screen 402. The second image is handled as the new first image, and the link image 403 is similarly displayed. Moreover, when the adjacent image is absent in the direction indicated by the link image 403 selected and operated by the user, no transition is made.

[0119]

Moreover, in the GUI example, when the user selects and operates a desired link image 403 (for example, the right arrow), if the adjacent image is present in the direction indicated by the link image 403 inside the same plane (for example, the side surface A1) having the first image, this adjacent image is selected. Furthermore, if the adjacent image is absent in the direction indicated by the link image 403 inside the same plane and if an image inside a different plane is present in the rear side or front side direction so as to interpose the above-described corner portion, this image is selected.

[0120]

As another GUI example, the link image 403 may be displayed so as to be overlapped on the image inside the frame 1501.

[0121]

5 As another GUI example, without displaying the link image 403, the adjacent image (second image) may be selected in response to a predetermined operation that is previously defined by a user's setting or others. For example, a function as a link in each of the directions may be assigned to, for example, each key of a
10 keyboard.

[0122]

As another GUI example, in place of the link image 403, by a predetermined operation with respect to a position of a line of the frame 1501, an adjacent image in a direction corresponding to
15 the position may be selected. For example, selection and operation of vicinity of a right side of the frame 1501 plays a role of the same function as the selection and the operation of the right arrow.

[0123]

As still another GUI example, in place of the link image 403,
20 a publicly-known operation, such as a dragging or swiping operation may be used. For example, the swiping operation from the right to the left side inside the frame 1501 plays a role of the same function as the selection and the operation of the right arrow.

[0124]

25 [Individual Screen (2)]

FIG. 16 shows a second example of the individual screen. In the GUI example of FIG. 16, when the image on the different plane interposing the corner portion (the closest image corresponding to the adjacent image) is present on the periphery of the first image,
30 a specific link image 404 indicating an image and a direction of such a type is displayed. This link image 404 is different in a shape from the link image 403. For example, when the adjacent image

is absent on the right side of the first image inside the same side surface while an image is present on a different side surface on the front or the rear side thereof as interposing the corner portion, a link image 404 indicating this state is displayed. In the present
5 example, when the adjacent image is present in the right rear side direction relative to the first image (for example, the image #21 on the side surface a3 relative to the image #3 on the side surface a2 is present in the vicinity of the corner portion 602 of FIG. 25), a link image 404 indicating the right rear side direction is
10 displayed. Moreover, when the adjacent image is present in the right front side direction relative to the first image (for example, the image on the side surface a2 relative to the image on the side surface a1 is present in the vicinity of the corner portion 601 of FIG. 25), a link image 404 indicating the right front side direction is
15 displayed.

[0125]

As another example of the link image, a link image 405 is shown. When the adjacent image is present on the up side in the Z-direction (the direction Z1) of the first image inside the same plane, an arrow
20 link image 403 indicating the upside direction is displayed. When the adjacent image is absent on the up side in the Z-direction (direction Z1) of the first image inside the same plane while an image corresponding to the horizontal surface such as the rooftop of the structural object 5 is present, a link image 405 indicating
25 this state is displayed. This link image 405 has a shape (for example, a diagonally bent shape) indicating the upper rear side direction. By the selection and the operation of this link image 405, the image located in the upper rear side direction can be selected as the next image.

30 [0126]

As another example of the link image, a link image 406 is shown. When the adjacent image having the smallest overlap state is absent

in a certain direction relative to the first image inside the same plane while an image is present at a distant position without overlapping, the link image 406 is displayed as a link image indicating this state. The link image 406 is different in a shape from the link image 403. For example, when the adjacent image is absent on the down side (direction Z2) of the first image while an image is present at a distant position, a link image 406 indicating the distant position in the downside direction is displayed. By the selection and the operation of this link image 406, the image at the distant position can be selected.

[0127]

[Individual Screen (3)]

FIG. 17 shows a third example of the individual screen. In the GUI example of the individual screen 402, the link image 403 is limited to be displayed depending on the presence or absence of the adjacent image. In the present example, it is assumed that the adjacent image is present at each of left side, downside and down left side positions of the first image while the adjacent image is absent at other positions as an adjacent image inside the same plane.

In this case, as shown in drawings, the link images 403 that are three arrows indicating the left side, the downside and the down left side are displayed. Moreover, in the present example, when an image on a different side surface is present on the right side of the first image, in particular, at a position on the right rear side thereof, a link image 404 that is an arrow indicating the right rear side is displayed as shown in the drawing. In this GUI example, since the display information amount is limited, the user can more easily carry out the operations.

[0128]

[Individual Screen (4)]

FIG. 18 shows a fourth example of the individual screen. When the first image is displayed inside the frame 1501 on the individual

screen 402, the image contents of the overlap region with the adjacent image are not displayed as they are, but contents without the overlap region (in other words, masked) are displayed. More specifically, the overlap region is indicated by expression such as black painting and shading. In the present example, the first image (or second image) has an overlap region 408. This overlap region 408 is a region where vicinity of a left side of an image selected as the next image and displayed inside the frame 1501 overlaps vicinity of a right side of a previous image (this region is shown with a broken line for convenience of explanation) that has been previously selected one step before the step.

[0129]

When the overlap region 408 is displayed to be removed as described above, the user does not need to check the image contents of the overlap region 408 of the selected image, and therefore, easily carry out the operations because a visual information amount is reduced. In the present example, the user can recognize that the overlap region 408 of the image has been already subjected to the deterioration inspection in the previous image, and therefore, it is not required to carry out the deterioration inspection for the overlap region 408 again in the deterioration inspection for the image. Thus, the deterioration inspection operation can be efficiently carried out.

[0130]

As another GUI example, information indicating that the deterioration inspection has been already carried out may be further added to the overlap region 408 and displayed. As still another GUI example, the overlap region 408 may be displayed as a frame line expression mode.

[0131]

[Individual Screen (5)]

Each of FIGs. 19A to 19C shows a fifth example of the individual

screen. In the individual screen 402, an unphotographed region (missing region) is displayed in a predetermined expression mode so as to be recognizable to the user. The unphotographed region (missing region) is a region in which a corresponding image is absent.

5 FIG. 19A shows an example of a relation between two images. This example shows a case of a large overlap rate in which an image 191 and an image 192 overlap each other. An unphotographed region 193 is a region out of these two images, and is exemplified as a region that has not been photographed in a group of images including these
10 two images. The unphotographed region 193 among the regions such as the side surface of the structural object 5 is not present as an image. Therefore, the unphotographed region 193 cannot be the target for the deterioration inspection or others. On the individual screen 402, a portion of such an unphotographed region
15 193 is displayed so as to be recognizable to the user. Thus, the user can recognize the portion of the unphotographed region 193, and therefore, can recognize a deterioration-inspection missing portion or others, and can also separately photograph this portion to carry out the deterioration inspection.

20 [0132]

Moreover, an unphotographed region 193b of another example is shown. This unphotographed region 193b is a region in a case with a clearance between an image 192 and an image 194. Basically, the images are photographed so that the images overlap. However,
25 a case of causing the unphotographed region 193b because of such a clearance for some reason (for example, erroneous aerial photographing) can be considered. Also in this case, the images are displayed so that the presence of the unphotographed region 193b is recognizable.

30 [0133]

FIGs. 19B and 19C show display examples of the unphotographed region 193 on the individual screen 402 so as to correspond to FIG.

19A. First, the example in FIG. 19B shows that a selected image 191 is displayed inside the frame 1501 without change in an image size of the image 191. For convenience of explanation, an overlapped image 192 is also shown by a frame line. At this time, the unphotographed region 193 is present on the outside of the frame 1501. When the unphotographed region 193 is present on the outside of the frame 1501 as shown, an image indicating the unphotographed region 193 may be displayed with a predetermined expression mode (for example, a dot pattern).

10 [0134]

The example in FIG. 19C shows that the image 191 is shifted (parallel movement) from the state in FIG. 19B and displayed in accordance with a user's predetermined operation. The present image display system has a function for shifting an image to be displayed inside the frame 1501 on the individual screen 402, a function for expanding/shrinking image display or others. For example, this shift display can be executed by carrying out an operation such as dragging or swiping of the first image or others, and the expanding/shrinking display can be executed by carrying out a pinching operation to the first image or others.

20 [0135]

In the present example, a center position (position Q1a) of the image 191 is moved from that of the state in FIG. 19B to, for example, a left and slightly-upside position Q1b by a shifting operation. This shift causes a state in which a part of the image 191, a part 193c of the unphotographed portion 193 and a part 192c of the image 192 are included inside the frame 1501. On the individual screen 402, the image parts included inside the frame 1501 are displayed, and the part 193c of the unphotographed region 193 is also displayed with a predetermined expression mode.

30 [0136]

[Individual Screen (6)]

FIG. 20 shows a sixth example of the individual screen. When an overlapped adjacent image of a certain first image is present, the presence of the adjacent image is displayed with an expression mode such as a frame line on the individual screen 402 so as to be recognizable to the user. In the present example, when the adjacent image is present at a position on the right side of the first image inside the frame 1501, not only the link image 403 but also an outline image 409 (for example, broken line) indicating an outline (side) of the adjacent image is displayed. Thus, the user can recognize that the adjacent image is present on, for example, the right side of the first image, and also recognize its overlap degree. When the user desires to select the adjacent image, the user selects and operates the link image 403 or the outline image 409. Thus, the adjacent image is selected and displayed inside the frame 1501.

[0137]

Moreover, in the example of FIG. 20, a GUI part (overlap rate threshold value setting column) 1503 for user's setting of the overlap rate threshold value TOL is displayed inside the individual screen 402. In the GUI part 1503, the overlap rate threshold value TOL that has been currently set is displayed, and a slide bar or others is installed so that the user can change the TOL value. In the present example, the user can check the state of the TOL value on the individual screen 402. Moreover, in accordance with the usage, operation state or others, the user can change the setting of the TOL value through the operation of the GUI part 1503. Furthermore, as shown in the example of FIG. 20, the actual overlap rate between the first image and the adjacent image may be displayed.

[0138]

Moreover, regarding the setting of the overlap rate threshold value TOL, not only one value but also two values may be used for setting the range. For example, the range of the overlap rate is set to be equal to or larger than 40% and equal to or smaller than

60%. In this case, an image corresponding to this range can be selected.

[0139]

[Deterioration Inspection Screen]

5 FIG. 21 shows an example of a deterioration inspection screen. In the image display system of the embodiment, the individual screen 402 becomes the deterioration inspection screen as it is. In a state in which an individual image is selected on the individual screen 402, the user can carry out the deterioration inspection operation while the image is taken as the target as it is. On the deterioration inspection screen, the selected image is displayed inside the frame 1501 as the deterioration inspection target image.

[0140]

15 The deterioration inspection includes, for example, a visual inspection carried out by a person and an automatic diagnosis carried out by a computer. The present image display system handles both of these functions. In the present example, the user carries out the visual inspection on the image inside the deterioration inspection screen. The user visually inspects the image, and determines the presence or absence of the deterioration and a deteriorated portion. For example, a case with a deteriorated portion 2101 such as a cracked portion or others inside the image is shown. On the deterioration inspection screen, the deteriorated portion found by the user through the visual inspection can be marked and displayed as an example of a deterioration inspection support process. For example, the user marks the deteriorated portion 2101 by carrying out a predetermined operation. As the marking operation example, an operation for surrounding the portion with a frame through a dragging operation or others is cited. In the marking image example, a red frame 2102 is displayed.

[0141]

Moreover, on the outside of the frame 1501, the image

information, the structural object information, etc. may be displayed. To the outside of the frame 1501, a checking item for the deterioration inspection (such as "inspected"/"uninspected state" or others can be input), a deterioration-presence/absence item, a comment input column, etc. may be provided.

[0142]

When the automatic diagnosis function is used, the computer system 1 estimates the deteriorated portion while taking the target image as its input. The image display system displays result information of the automatic diagnosis made by the computer system 1 on the deterioration inspection screen. For example, the deteriorated portion that has been estimated is displayed with a predetermined expression mode. The user refers to the result, and then, makes checking and final determination.

[0143]

In an image display system in a modified example, note that a deterioration inspection screen may be provided separately from the individual screen 402 so that these screens are transited from each other on the basis of a predetermined operation (for example, double tapping or others).

[0144]

[Structural-Object Three-Dimensional Model Screen]

FIG. 22 shows an example of a structural-object three-dimensional model screen. The present image display system displays the structural-object three-dimensional model screen when receiving a predetermined operation on the list screen 401 or others. The present image display system displays the structural-object three-dimensional model in a region inside the screen on the basis of the three-dimensional model data d5, and displays the structural object information or others together. In this region, for example, the structural-object three-dimensional model is overlapped with and displayed on a map (a site or others) as a perspective view.

In accordance with a predetermined operation to this screen, a viewing direction and a position of the structural-object three-dimensional model or others can be changed.

[0145]

5 Moreover, regarding the structural-object three-dimensional model, a region such as a side surface or others can be selected and specified by a predetermined user's operation. In the present image display system, for example, when a certain side surface is selected and specified, a group of images that is associated with
10 the side surface are displayed on the list screen 401. Alternatively, when a certain position of the structural-object three-dimensional model is selected and specified, an image that is associated with the position may be displayed on the individual screen 402.

[0146]

15 [List Screen (2)]

FIG. 23 shows a second example of the list screen. On this list screen 401, a group of images that is the deterioration inspection target in an original group of images is displayed as a list. First, the user selects the group of images that is the
20 deterioration inspection target through the above-described individual screen 402. Then, the image display system displays the group of images (group of selected images) that is the deterioration inspection target on the list screen 401 as a list. On the basis of a predetermined operation (for example, pushing of a display
25 button for the group of selected images) inside the list screen 401, the group of selected images may be displayed. Moreover, on this screen, regarding the group of images that is the deterioration inspection target (group of selected images), the deterioration inspection information (such as the inspected state and the
30 deterioration presence/absence) may be displayed together for each of images.

[0147]

[List Screen (3)]

FIG. 24 shows a third example of the list screen. As a modified example of the list screen 401 of FIG. 23, a list screen 401 described here shows a different system when displaying the list of the group of images that is the deterioration inspection target. On this list screen 401, the group of images that is the deterioration inspection target is arranged and displayed on the basis of a positional relation depending on a shape of the surface region of the structural object 5 (or depending on the generated structural-object three-dimensional model). For example, in a region 2401 inside the list screen 401, a group of images (group of adjacent images) that is the deterioration inspection target is displayed for each of the selected side surface groups. For example, as a group of adjacent images of a side surface a2 of FIG. 25, there are images #1 to #12. In this region, first, a region 2401 corresponding to a side surface (that is, partial plane region) of the selected group is displayed. Inside the region 2401, a plurality of adjacent images (image #1 to image #12) are arranged and displayed in accordance with the actual positional relation. Moreover, each of images (thumbnails) is displayed with a predetermined expression mode so that the inspected state, the deterioration presence/absence or others is recognizable. When one image inside the region 2401 is selected and operated, the image is displayed on the individual screen 402.

[0148]

Moreover, in the region 2401, a link image 2402 for use in selecting a different side surface group may be displayed. For example, when a right-arrow link image 2402 is selected and operated, a group in the side surface a3 is selected and similarly displayed in the region 2401. Moreover, the display example of the link image 2402 in FIG. 24 in terms of a side surface group shows right and left arrow shapes. However, the expression mode is not limited to this, and various expression modes are applicable. For example,

as similar to the example of the link image 404 in FIG. 16, the link image 2402 may have an arrow shape indicating change toward the front or rear direction in the three-dimensional space. For example, the link image 2402 for a link from the side surface a2 to the side surface a3 is displayed with a bent arrow shape indicating a right rear direction.

[0149]

[Determination on Adjacent Image]

With reference to FIGs. 25 and 26, determination on the adjacent image (next image) in the spatial positional relation, the GUI and others will be described. In particular, as shown in the example in FIGs. 6A and 6B, the positional relation between the images of the side surfaces interposing the corner portion of the structural object 5 and the selection and determination on the next image will be described. A plurality of images (and photographing areas) are arranged inside a three-dimensional space. In a case of handling a group of images that have been obtained by photographing a corner portion, a different side surface, a curved surface, etc. in the three-dimensional structural object 5, the camera directions C of the respective images are correspondingly different from one another in some cases. Among such images that are different from one another in the camera direction C, it is sometimes difficult to determine the overlap rate and the adjacent image. For this reason, the present image display system (in particular, adjacent-image determination unit 303) has a function of determining the positional relation between the images and determining a next image of a certain image by using information of the positions and the directions of the images (for example, the camera direction C and the camera direction V) even when the camera directions C are different from one another. When an overlap rate in a pair of images in a space is calculated, the present image display system determines the pair of images by using the positional

information of the images in consideration of the efficiency.

[0150]

FIG. 25 shows an example of image relation between the side surfaces of the structural object 5 so as to correspond to the example of FIGs. 6A and 6B. In the present example, an example of the adjacent images of the side surface a2 and the side surface a3 of the structural object 5 is shown. In this case, the adjacent images described here indicate a group of images selected as suitable images for use in the deterioration inspection. Although each of the images is shown with a broken-line frame, end portions of the images are practically partially overlapped with each other.

[0151]

The side surface a2 has a corner portion 601 on the left side inside the plane, that is, on the rear side (direction Y1) in the Y-direction, and a corner portion 602 on the right side inside the plane, that is, on the front side (direction Y2) in the Y-direction. The side surface a3 has the corner portion 602 on the left side (direction X1) inside the plane, and a corner portion 603 on the right side (direction X2) inside the plane. Along a route r2 of a group for the side surface a2, the group of images is photographed by the aerial photographing process as described above in the scanning process. An example of such a group of adjacent images as selected to have the smallest overlap state in the group of images is shown as images #1 to #12. Similarly, along a route r3 of a group for the side surface a3, the group of images is photographed by the aerial photographing process as described above in the scanning process. An example of such a group of adjacent images as selected to have the smallest overlap state in the group of images is shown as images #21 to #32. Each image number corresponds to an order of the photographing time and date. Illustration of images that have not been selected because of a large overlap rate is omitted.

[0152]

In the present image display system, one image selected by the user is displayed on the individual screen 402. For example, it is assumed that the image #3 is selected as the first image. In this case, when only the Y-Z plane of the side surface a2 is considered, the images #2, #4 and #5 are present as the adjacent images. In this case, when the three-dimensional space is considered, the left end portion of the side surface a3 is connected to the right end portion of the side surface a2 at the corner portion 602 as shown in the drawing. When the user views the image #3 on the individual screen 402, the adjacent image is absent on the right side (direction Y2) of the image #3 because of no structural object thereon. However, in consideration of a three-dimensional positional relation including a direction to turn from the side surface a2 to the side surface a3 along the surface shape of the structural object 5, the image #21 of the side surface a3 is present in a proceeding direction toward the right rear side of the image #3. Similarly, when viewed from the image #21 of the side surface a3, the image #3 of the side surface a2 is present in a proceeding direction toward the left rear side.

[0153]

In the usage for the deterioration inspection or others, also for the case of the above-described positional relation between the image #3 and the image #21, the selection in the images and the display are helpful. Therefore, the present image display system has a function capable of selecting and displaying the images even when an image on a certain side surface is continued to an image on a different side surface as described above (even when images that are different from each other in the camera direction but are close to each other are present). For this reason, by using the information of the image position and direction, the present image display system determines the three-dimensional positional relation between the images (FIG. 26) and also determines the

adjacent image between the side surfaces, and shows the link image. For example, when the image #3 is displayed on the individual screen 402, not only a link image indicating the left side or the down side direction but also a link image indicating the right rear side (FIG. 17, link image 404) is displayed as the link image.

[0154]

In the adjacent image between the side surfaces as described above, the overlap region between the images is absent in some cases. For this reason, in determining the adjacent image between the side surfaces, the present image display system determines not the overlap rate inside the same plane but mainly the three-dimensional positional relation or distance (S10 in FIG. 4 or others).

[0155]

Similarly, regarding the relation between the side surface a2 and the side surface a3, a pair of the image #4 and the image #26, a pair of the image #9 and the image #27 and a pair of the image #10 and the image #32 are obtained as the adjacent images. Similarly, an adjacent image can be also obtained between side surfaces interposing a different corner portion.

[0156]

FIG. 26 shows an example of determination on the image selection between the side surfaces of the structural object 5 so as to correspond to FIG. 25. FIG. 26 shows the side surface a1, the side surface a2, the side surface a3, the corner portion 601, the corner portion 602 and others as an overhead view. Positions c1, c2 and c3 are exemplified as the camera positions C at the time of photographing on the route r1 of the side surface a1. These positions are close to the corner portion 601 of the side surface a1. At all the positions, the camera direction is the direction Y1, and the target distance D0 is constant. For example, an image g11 (in particular, a width in the photographing area) at the time of photographing at the position c3 is shown. Moreover, positions

c4, c5 and c6 or others are exemplified as the camera positions C at the time of photographing on the route r2 of the side surface a2. These positions are close to the corner portion 601 of the side surface a2. At all the positions, the camera direction is the direction X2, and the target distance D0 is constant. For example, an image g12 (in particular, a width in the photographing area) at the time of photographing at the position c4 (assumed to be almost the same position as the position c3) is shown.

[0157]

As the adjacent image of the image g11 on the side surface a1, the present image display system determines not only the adjacent image inside the same plane but also an image (image g12) on a different side surface. At this time, by using the positional information of the camera position C of each image, the present image display system calculates a distance between the camera positions C, and determines the images. The present image display system excludes, for example, the images on the same side surface (images at the positions c1, c2 or others) as that at the position c3 of the image g11, and determines an image having the smallest distance between the camera positions C. In the present example, the distance from the position c3 to the position c4 is the smallest. Therefore, the image g12 of the position c4 is picked up as the adjacent image between the side surfaces. The present image display system associate the image g12 with the image g11 as the adjacent image between the side surfaces (referred to as "adjacent image" in the case of the image between the side surfaces even without the overlap state), and displays a corresponding link image.

[0158]

As another example of the process, note that the present image display system may determine the above-described distance by not using the camera position C but approximately using information of the drone position P. Moreover, as still another example of the

process, the present image display system may determine the above-described distance by not using the camera position C but using information of the center position Q between the corresponding image and the corresponding photographing area. For example, it is
5 assumed that a center position of the image g11 is a position "q3" and a center position of the image g12 is a position "q4". The present image display system determines an image having the smallest distance between the center positions of the images except for an image inside the same side surface. In the present example, the
10 distance from the position q4 to the position q3 is the smallest. Therefore, the image g12 at the position q4 is picked up as the adjacent image between the side surfaces.

[0159]

Also in a relation between the side surface a2 and the side
15 surface a3 interposing the corner portion 602, the adjacent image can be determined as similar to the above description. For example, when the image g13 at the position c13 (or the position q13) on the side surface a2 is set as the first image, the image g14 at the position c14 (or the position q14) on the side surface a3 can be
20 picked up as the adjacent image.

[0160]

When the image g11 is displayed on the individual screen 402, a link image indicating a right front side (direction Y2) is displayed as the link image. By the selection of this link image,
25 transition to the image g12 can be made. When the image g12 is displayed on the individual screen 402, a link image indicating a left front side (direction X1) is displayed as the link image. By the selection of this link image, transition to the image g11 can be made. When the image g13 is displayed on the individual screen
30 402, a link image indicating a right rear side (direction X2) is displayed as the link image. By the selection of this link image, transition to the image g14 can be made. When the image g14 is

displayed on the individual screen 402, a link image indicating a left rear side (direction Y1) is displayed as the link image. By the selection of this link image, transition to the image g13 can be made.

5 [0161]

Note that such display image transition through the link image is associated with the change in the user's line-of-sight direction associated with the change in the camera direction C. By the GUI of the present image display system, the image selection and the display image transition in the direction along the surface shape of the three-dimensional structural object 5 are achieved. Thus, the user can more efficiently carry out the operations in accordance with the usage for the deterioration inspection or others.

[0162]

15 Note that the present invention is not limited to the mode of the determination on the positional relation between the images by using the information of the image position and direction as described above, the present invention can be carried out. As a modified example, the image positional relation may be determined on the basis of determination on characteristic points or others extracted from inside of the image through an image processing operation.

[0163]

[Aerial Photographing System (3)]

25 Each of FIGs. 27A and 27B shows a third example of an aerial photographing system for a different structural object 5 as an applied example. The drawing shows a case in which the structural object 5 of the present example has a column shape. When a region on a side surface A30 having a curved surface of the structural object 5 is set to the deterioration inspection target, the following aerial photographing system is used. FIG. 27A is a perspective view and 30 FIG. 27B is an overhead view in the Z-direction. As shown in drawings,

an aerial-photography setting example of this system is shown as, for example, a route R30 on which the drone 10 and the camera 4 are circumferentially and horizontally moved relative to the curved side surface A30 so that the target distance D0 is substantially
5 constant. On this route R30, the camera direction is controlled so as to, for example, be directed perpendicular to the curved side surface A30. For example, an image g31 at a camera position c31, an image g32 at a camera position c32, an image g33 at a camera position c33, etc., on the route R30 are shown.

10 [0164]

Also to a case of a group of images obtained by such an aerial photographing system, the processes of the present image display system can be similarly applied, so that the substantially same effects can be obtained. The present image display system similarly
15 determines the overlap rate, the adjacent image and others of a plurality of images (photographing area) formed along the side surface A30. In this case, on the individual screen 402, each image can be selected in a direction along the side surface A30. In the case of this aerial photographing process, since the target distance
20 D0 is constant in particular, the deterioration inspection can be easily carried out, and the accuracy in the SFM process can also be ensured. The system is not limited to this aerial photographing process, but may be a system in which the route is divided into a plurality of linear routes as described above.

25 [0165]

[Process Timing]

In the image display system of the present embodiment, as shown in a flow (S6) in FIG. 4, the computer system 1 execute the processes of determining the overlap rate and the adjacent image at each timing
30 at which a certain first image is selected by a user's operation. The processing timing is not limited to this, and may be any timing. As a modified example, the computer system 1 (for example, server

3) previously executes the overlap rate calculation and the adjacent-image determination process relative to the group of images as a batch process at a timing at which data of the group of images is input or at which the execution of the batch process
5 is specified by the user. As a result of this process, the group of target images of the group of original images can be collectively selected in accordance with the usage of the deterioration inspection or others. For example, as shown in the example of FIG. 25, a group of adjacent images having a positional relation in a
10 three-dimensional space can be formed. The computer system 1 manages information of the group of adjacent images formed by this process together with three-dimensional model data of the structural object 5 or others. Moreover, the computer system 1 can display information of the group of adjacent images on a GUI screen
15 (for example, see FIG. 23 and FIG. 24) in accordance with a user's operation.

[0166]

Moreover, the group of images to be input is changed in some cases. For example, in some cases, some images are added later.
20 For example, when an unphotographed region is caused in the first photographing process, the unphotographed region is photographed as the target in the second photographing. In such a case, the computer system 1 carries out the same process on the added images. That is, the computer system 1 executes the similar overlap rate
25 calculation and adjacent-image determination process again while using the added image as the first image and using the processed group of images as the candidate images. Thus, the group of adjacent images of the added image is formed, and the relation of the group of images is restructured and updated.

30 [0167]

[Effects and Others]

As described above, in the image display system of the

embodiment, when an image for use in the deterioration inspection is selected from the group of images photographed by the camera 4 of the drone 10, a suitable image can be easily selected, so that time and effort of user's operations can be reduced. In accordance with the usage, in many cases, the user carries out the checking and the operation while viewing a certain image (first image), and then, selects a certain image located on the periphery of the image, and carries out the checking and the operation while viewing the image (second image). In such a case, the present image display system can efficiently select and operate the group of images. In the present embodiment, in the usage for deterioration inspection, the user can efficiently operate the visual inspection. Also in an automatic diagnosis using a computer, the computer can efficiently carry out the processes on the group of selected images.

15 [0168]

As described above, the image display system of the embodiment has a mechanism of determining an overlap state relating to an object inside an image while using a plurality of two-dimensional images having a positional relation in a three-dimensional space as targets, and a mechanism such as a GUI of navigating selection and transition among images in accordance with the overlap state. In particular, in the present image display system, the images can be selected and transited in a positional relation and a direction in terms of the three-dimensional shape of the surface of the structural object 5.

25 [0169]

When the user selects and displays a first image on the individual screen 402, the present image display system searches the image located on the periphery of the first image, determines the adjacent image on the basis of the overlap rate, and shows the corresponding link image. Thus, since the present image display system carries out efficiently the processes, waiting time of the user can also be reduced.

[0170]

The present image display system is not limited to be intended to carry out the deterioration inspection and generate the three-dimensional model, and is applicable to another usage. Even
5 in the case of the application to another usage, a suitable image can be selected in the group of images and between the images in accordance with the overlap rate depending on the usage, so that the operation and the process in accordance with the usage can be efficiently carried out.

10 [0171]

To an image display system as a modified example, a mode without the three-dimensional model generation function is also applicable.

[0172]

15 The present image display system has a configuration in which a group of images to be input are obtained manually or by using the drone 10. However, the system is not limited to this configuration, the group of images to be input may be obtained by using any means. Moreover, in the present image display system, in particular, the
20 case of handling the group of images used for both the deterioration inspection process and the three-dimensional model generation has been described. In particular, the case of the selection of the group of partial images that is suitable for the deterioration inspection from the group of images photographed so as to generate
25 the three-dimensional model has been described. The system is not limited to this case. The present image display system is effectively applied to a case of selection of a group of second images for a different second usage from a group of first images photographed for a first usage.

30 [0173]

In the foregoing, the present invention has been concretely described on the basis of the embodiments. However, the present

invention is not limited to the foregoing embodiments and various modifications can be made within the scope of the present invention.

What is claimed is:

1. An image display system configured by a computer system,
wherein the computer system
inputs a group of images including a plurality of images that
5 are different from one another in photographing time and date,
position and direction,
displays a list of the group of images on a list screen,
displays a first image selected from the group of images on
the basis of a user's operation on an individual screen,
10 determines an adjacent image of the first image on the basis
of determination on a spatial positional relation in a pair of the
first image and a candidate image spatially located on a periphery
of the first image and determination on an overlap state relating
to a photographing area, and
15 selects the adjacent image of the first image as a second image
on the individual screen on the basis of the user's operation, and
displays the second image as a new first image.
2. The image display system according to claim 1,
20 wherein the computer system displays a link image indicating
presence of the adjacent image of the first image and a direction
of the adjacent image on the individual screen, selects the adjacent
image as the second image on the basis of the user's operation
relative to the link image, and displays the second image as a new
25 first image.
3. The image display system according to claim 1,
wherein the computer system calculates an overlap rate in the
photographing area in the pair of the first image and the candidate
30 image as the overlap state, and selects the candidate image in which
the overlap rate is the smallest within a range of overlap rate
threshold values as the adjacent image.

4. The image display system according to claim 1,

wherein the computer system calculates a distance between the position of the first image and the position of the candidate image as the spatial positional relation in the pair of the first image and the candidate image by using image information containing the photographing position of each image in the group of images, and selects the candidate image having the smallest distance as the adjacent image.

10

5. The image display system according to claim 1,

wherein the computer system separately determines the adjacent image in each of a case in which the photographing direction of the first image and the photographing direction of the candidate image are substantially the same as each other and a case in which those directions are different from each other as the spatial positional relation in the pair of the first image and the candidate image by using image information containing the photographing position of each image in the group of images.

20

6. The image display system according to claim 2,

wherein the computer system displays a link image having a shape indicating a direction in which the adjacent image of the first image is present, as the link image on the individual screen.

25

7. The image display system according to claim 2,

wherein, in a case of the spatial positional relation with a second direction inside a second plane on which the photographing area of the adjacent image is arranged relative to a first direction inside a first plane on which the photographing area of the first image is arranged, the computer system displays a link image having a shape indicating a change from the first direction to the second

30

direction, as the link image on the individual screen.

8. The image display system according to claim 1,

5 wherein, in a case with an overlap region between the first image and the adjacent image, the computer system displays the overlap region of the first image on the individual screen by using a predetermined expression mode in which an image content is removed.

9. The image display system according to claim 1,

10 wherein, in a case with an unphotographed region on the periphery of the first image, the computer system displays the unphotographed region on the periphery of the first image on the individual screen by using a predetermined expression mode indicating presence of the unphotographed region.

15

10. The image display system according to claim 1,

wherein, in a case with an overlap region between the first image and the adjacent image, the computer system displays the overlap region of the first image on the individual screen by using
20 an outline of the overlap region or a predetermined expression mode indicating the overlap region.

11. The image display system according to claim 1,

25 wherein the computer system displays, on the list screen, a list of a group of images selected from the group of images by the user's operation on the individual screen.

12. The image display system according to claim 1,

30 wherein the computer system arranges a group of images selected from the group of images by the user's operation on the individual screen in accordance with the spatial positional relation, and displays the group of images on the list screen.

13. The image display system according to claim 1,
wherein the group of images is a group of images photographed
by a camera for usage of deterioration inspection on a surface region
5 of a structural object, and
the individual screen is a deterioration inspection screen
on which a user's operation for an operation of the deterioration
inspection is received.

10 14. The image display system according to claim 1,
wherein the group of images is a group of images photographed
by a camera for usage of generating a three-dimensional model of
a structural object.

15 15. The image display system according to claim 1,
wherein the group of images is a group of images aerially
photographed by a flying body on which a camera is mounted.

16. an image display method in an image display system configured
20 by a computer system, comprising the steps of, the steps being
executed by the computer system, :

inputting a group of images including a plurality of images
that are different from one another in photographing time and date,
position and direction;

25 displaying a list of the group of images on a list screen;
displaying a first image selected from the group of images
on the basis of a user's operation on an individual screen;

determining an adjacent image of the first image on the basis
of determination on a spatial positional relation in a pair of the
30 first image and a candidate image spatially located on a periphery
of the first image and determination on an overlap state relating
to a photographing area; and

selecting the adjacent image of the first image as a second image on the individual screen on the basis of the user's operation, and displaying the second image as a new first image.

5 17. The image display method according to claim 16 further comprising the step of

making the computer system display a link image indicating presence of the adjacent image of the first image and a direction of the adjacent image on the individual screen, select the adjacent
10 image as the second image on the basis of the user's operation relative to the link image, and display the second image as a new first image.

18. The image display method according to claim 16 further
15 comprising the step of

making the computer system calculate an overlap rate in the photographing area in the pair of the first image and the candidate image as the overlap state, and select the candidate image in which the overlap rate is the smallest within a range of overlap rate
20 threshold values as the adjacent image.

19. The image display method according to claim 16 further comprising the step of

making the computer system calculate a distance between the
25 position of the first image and the position of the candidate image as the spatial positional relation in the pair of the first image and the candidate image by using image information containing the photographing position of each image in the group of images, and select the candidate image having the smallest distance as the
30 adjacent image.

20. The image display method according to claim 16 further

comprising the step of

making the computer system separately determine the adjacent image in each of a case in which the photographing direction of the first image and the photographing direction of the candidate image are substantially the same as each other and a case in which those directions are different from each other as the spatial positional relation in the pair of the first image and the candidate image by using image information containing the photographing position of each image in the group of images.

10

21. The image display method according to claim 17 further comprising the step of

making the computer system display a link image having a shape indicating a direction in which the adjacent image of the first image is present, as the link image on the individual screen.

15

22. The image display method according to claim 17 further comprising the step of,

in a case of the spatial positional relation with a second direction inside a second plane on which the photographing area of the adjacent image is arranged relative to a first direction inside a first plane on which the photographing area of the first image is arranged, making the computer system display a link image having a shape indicating a change from the first direction to the second direction, as the link image on the individual screen.

20

25

23. The image display method according to claim 16 further comprising the step of,

in a case with an overlap region between the first image and the adjacent image, making the computer system display the overlap region of the first image on the individual screen by using a predetermined expression mode in which an image content is removed.

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24. The image display method according to claim 16 further comprising the step of,

5 in a case with an unphotographed region on the periphery of the first image, making the computer system display the unphotographed region on the periphery of the first image on the individual screen by using a predetermined expression mode indicating presence of the unphotographed region.

10 25. The image display method according to claim 16 further comprising the step of,

in a case with an overlap region between the first image and the adjacent image, making the computer system display the overlap region of the first image on the individual screen by using an outline
15 of the overlap region or a predetermined expression mode indicating the overlap region.

26. The image display method according to claim 16 further comprising the step of,

20 on the list screen, making the computer system display a list of a group of images selected from the group of images by the user's operation on the individual screen.

27. The image display method according to claim 16 further comprising the step of

making the computer system arrange a group of images selected from the group of images by the user's operation on the individual screen in accordance with the spatial positional relation, and display the groups of images on the list screen.

30

28. The image display method according to claim 16,
wherein the group of images is a group of images photographed

by a camera for usage of deterioration inspection on a surface region of a structural object, and

the individual screen is a deterioration inspection screen on which a user's operation for an operation of the deterioration inspection is received.

29. The image display method according to claim 16,
wherein the group of images is a group of images photographed by a camera for usage of generating a three-dimensional model of a structural object.

30. The image display method according to claim 16,
wherein the group of images is a group of images aerially photographed by a flying body on which a camera is mounted.