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(54) **STORAGE-RETRIEVAL MANAGEMENT DEVICE, STORAGE-RETRIEVAL MANAGEMENT SYSTEM, AND STORAGE-RETRIEVAL MANAGEMENT METHOD**

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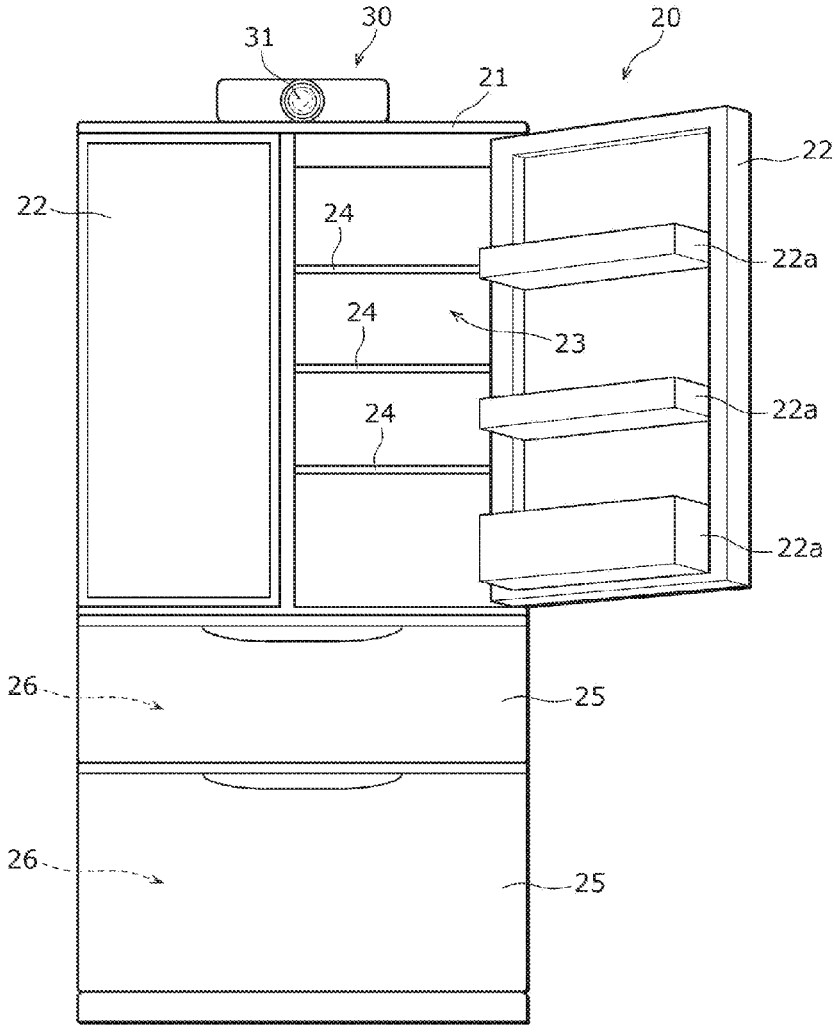
(57) **ABSTRACT**

A storage-retrieval management device includes: an image capturer that captures images each including markers as subjects from above a refrigerator that includes a first storage structure and a second storage structure, the images showing a scene in which an object is put into or taken out of the refrigerator, the markers being provided on the first storage structure and the second storage structure, the second storage structure being at a position different from a position of the first storage structure in a vertical direction; and a determiner that determines a storage position at which the object is stored, based on whether the markers included in the images are visible or hidden.



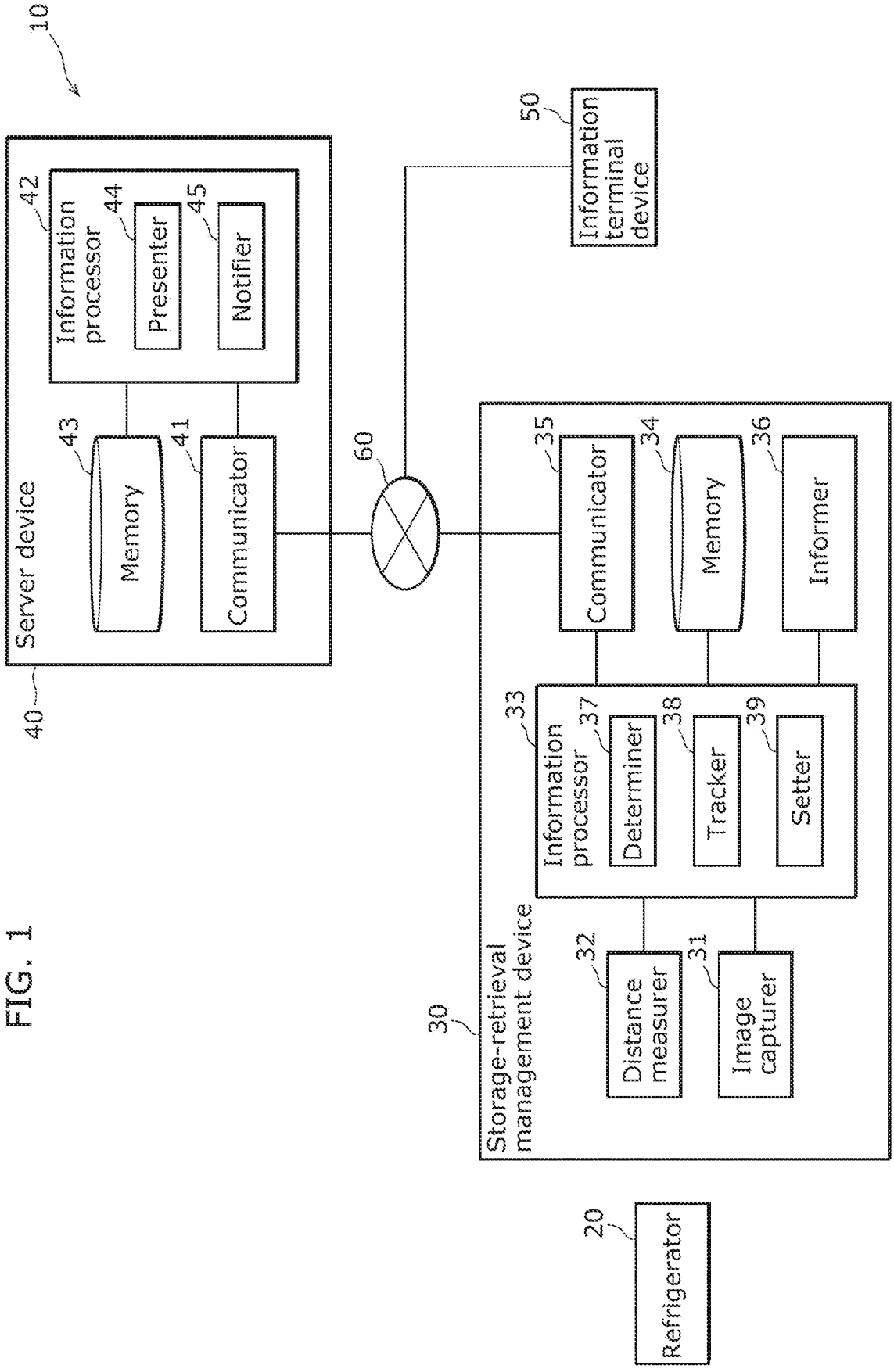

10
Server device
40
Information processor
42
Presenter
44
Notifier
45
Memory
43
Communicator
41
60
50
Information terminal device
Storage-retrieval management device
30
Communicator
35
Memory
34
Informer
36
Information processor
33
Determiner
37
Tracker
38
Setter
39
Distance measurer
32
Image capturer
31
20
Refrigerator

FIG. 1

FIG. 2

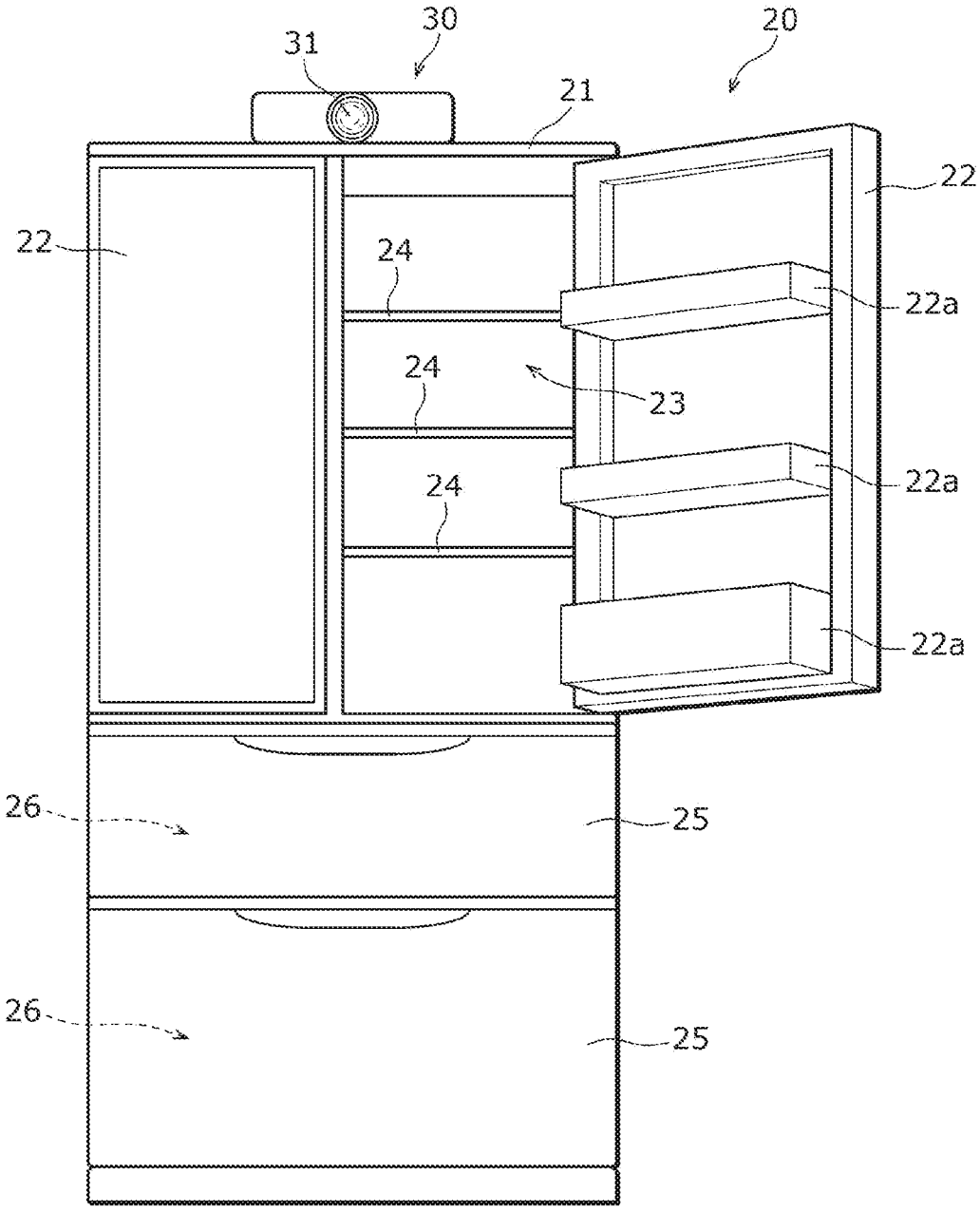


FIG. 3

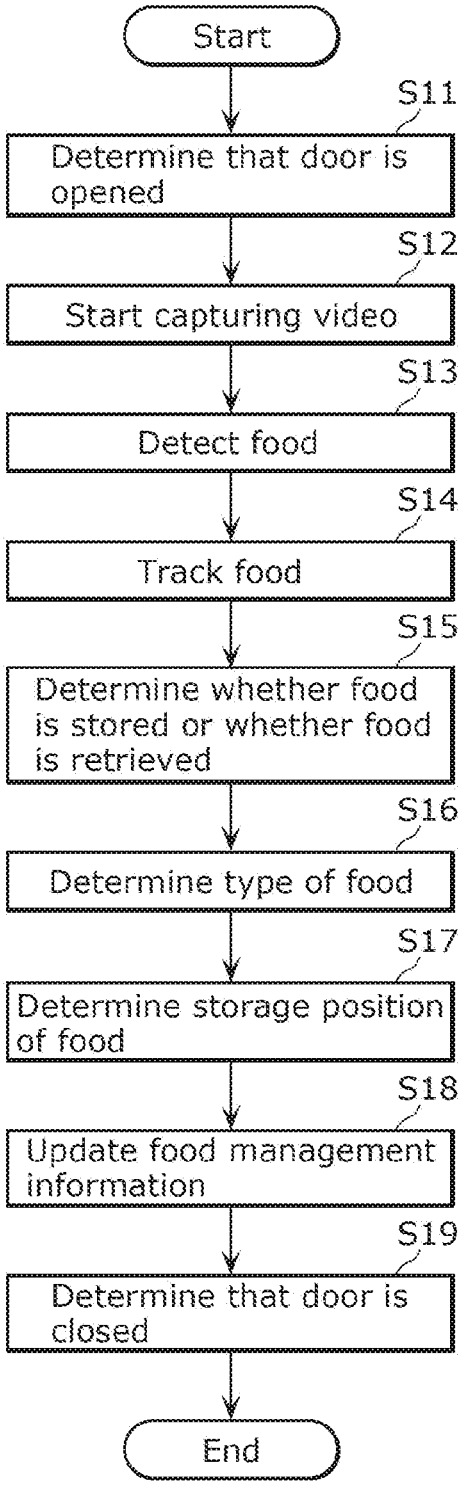

Start
S11
Determine that door is opened
S12
Start capturing video
S13
Detect food
S14
Track food
S15
Determine whether food is stored or whether food is retrieved
S16
Determine type of food
S17
Determine storage position of food
S18
Update food management information
S19
Determine that door is closed
End

FIG. 4

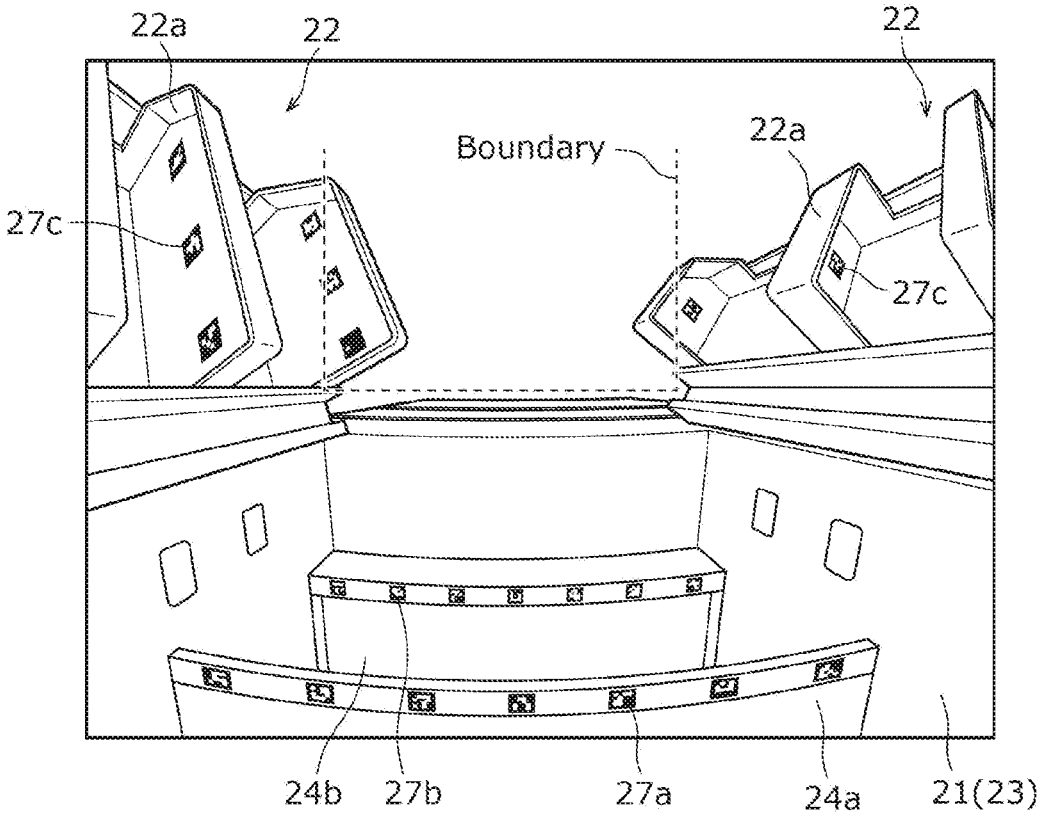


FIG. 5

Upper shelf		Lower shelf		Door compartment 1		..
Type of food	Quantity	Type of food	Quantity	Type of food	Quantity	..
Drink	3	Drink	2	Drink	1	..
Vegetable	5	Vegetable	4	Vegetable	0	..
Meat	2	Meat	3	Meat	0	..
..	..	..	..	..	..	..

FIG. 6

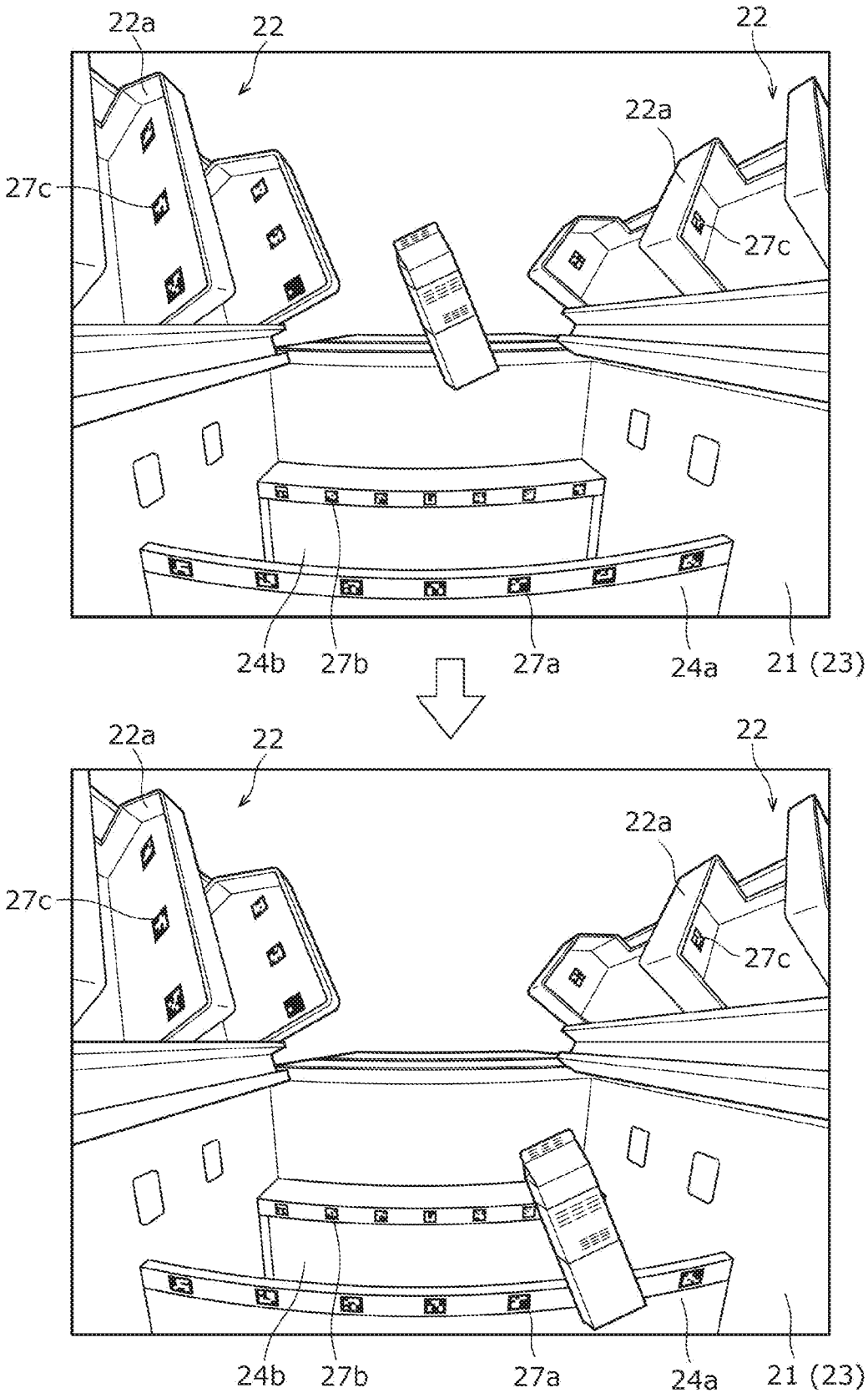

22a
22
22
22a
27c
27c
24b
27b
27a
24a
21 (23)
22a
22
22
22a
27c
27c
24b
27b
27a
24a
21 (23)

FIG. 7

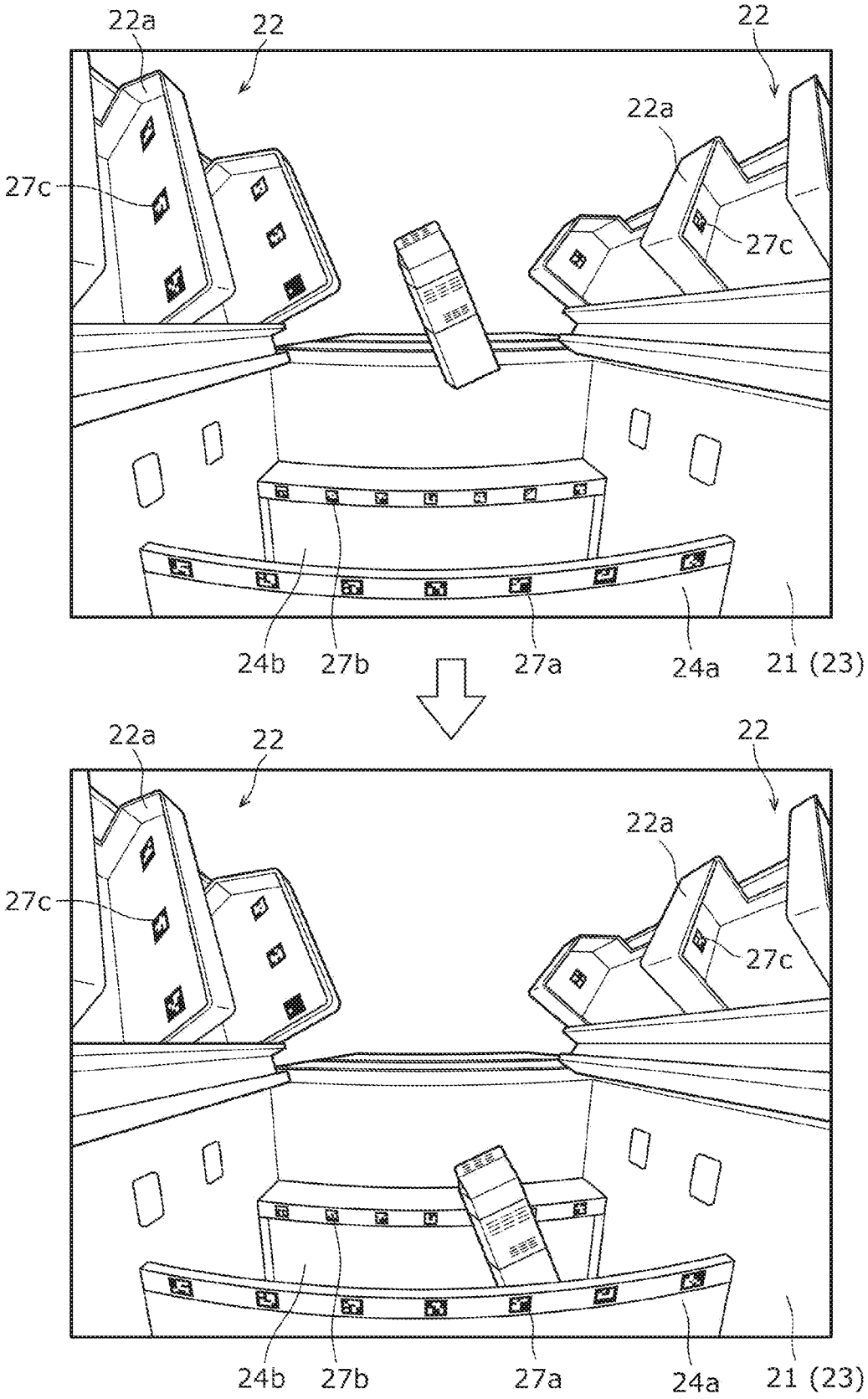

22a
22
22
22a
27c
27c
24b
27b
27a
24a
21 (23)
22a
22
22
22a
27c
27c
24b
27b
27a
24a
21 (23)

FIG. 8

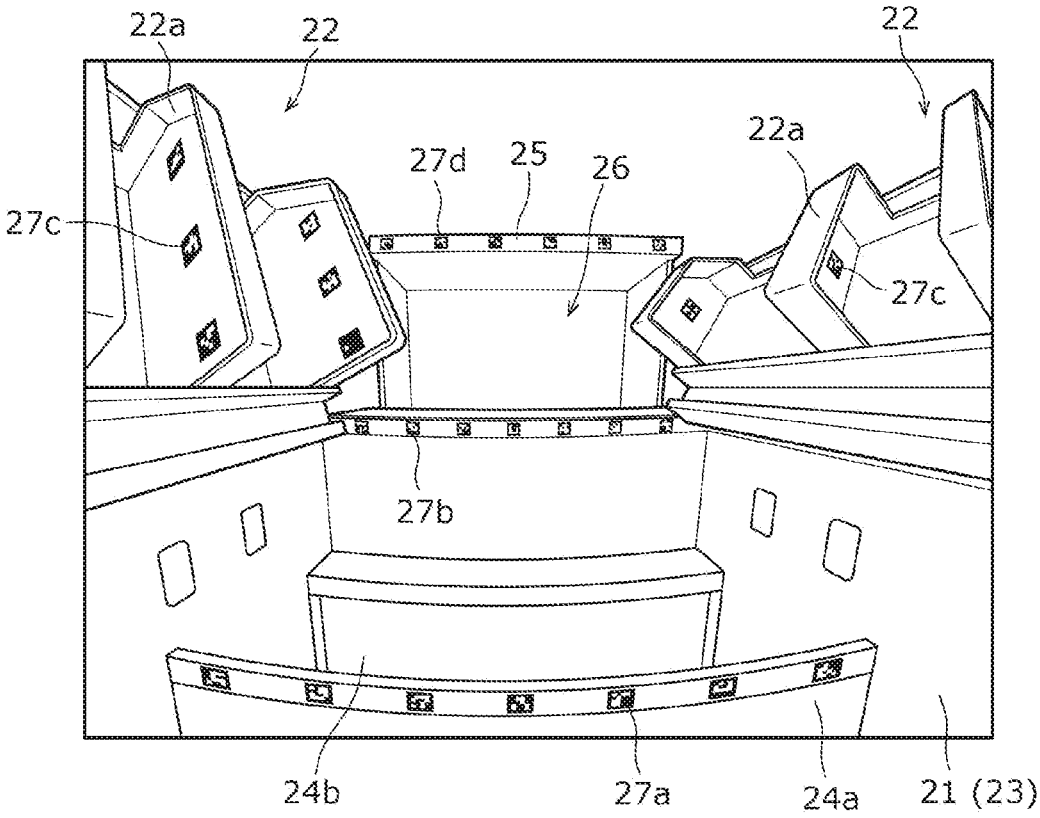


FIG. 9

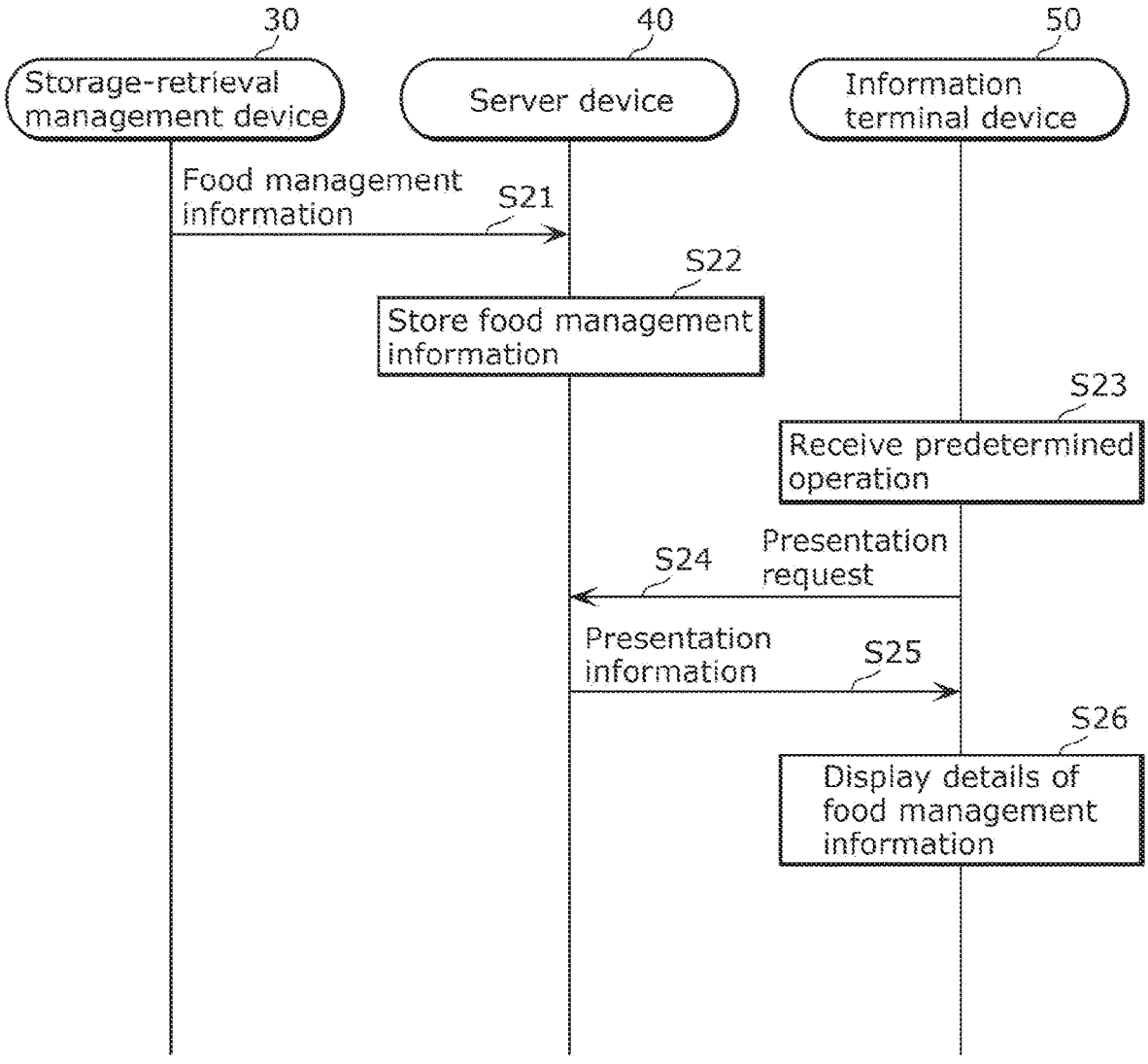

30
40
50
Storage-retrieval management device
Server device
Information terminal device
Food management information
S21
S22
Store food management information
S23
Receive predetermined operation
Presentation request
S24
Presentation information
S25
S26
Display details of food management information

FIG. 10

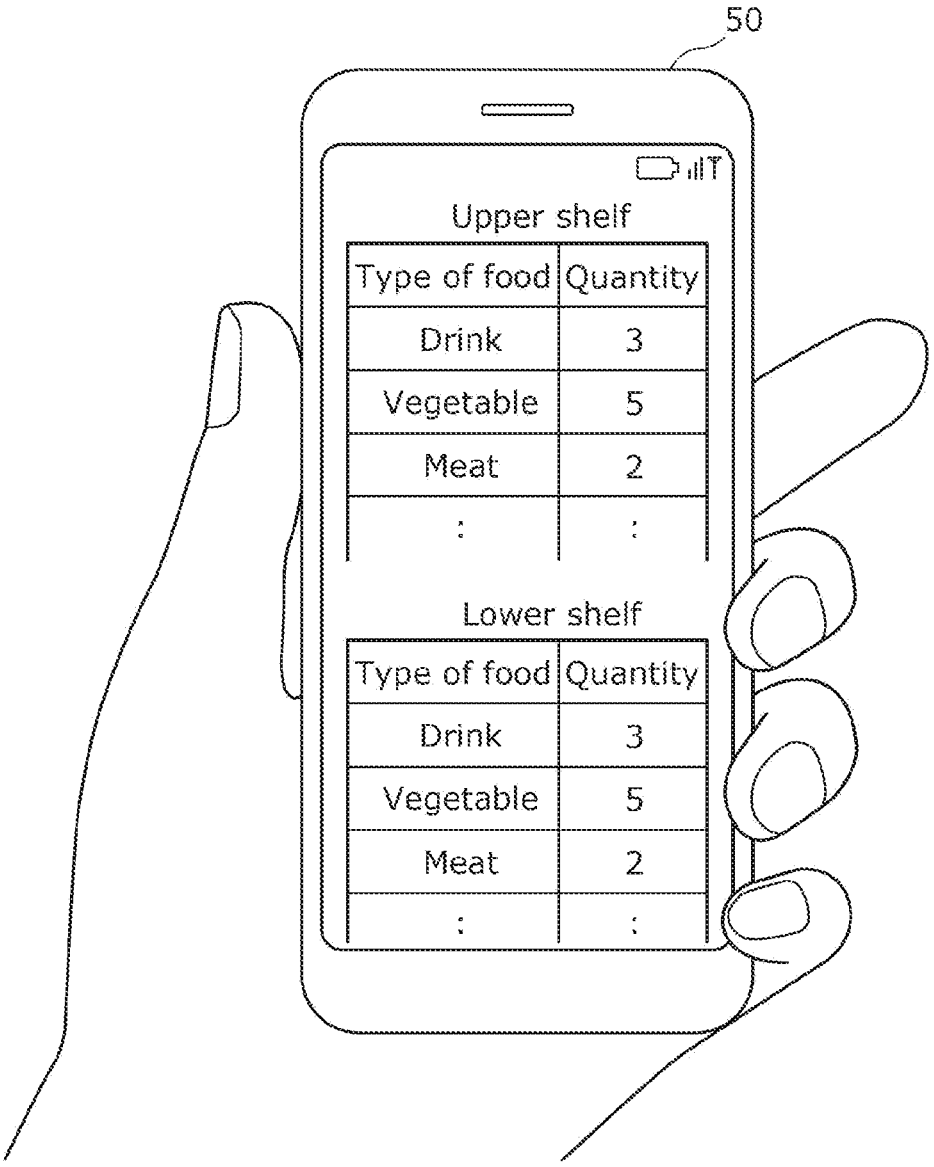

50
Upper shelf
Type of food
Quantity
Drink
3
Vegetable
5
Meat
2
:
:
Lower shelf
Type of food
Quantity
Drink
3
Vegetable
5
Meat
2
:
:

FIG. 11

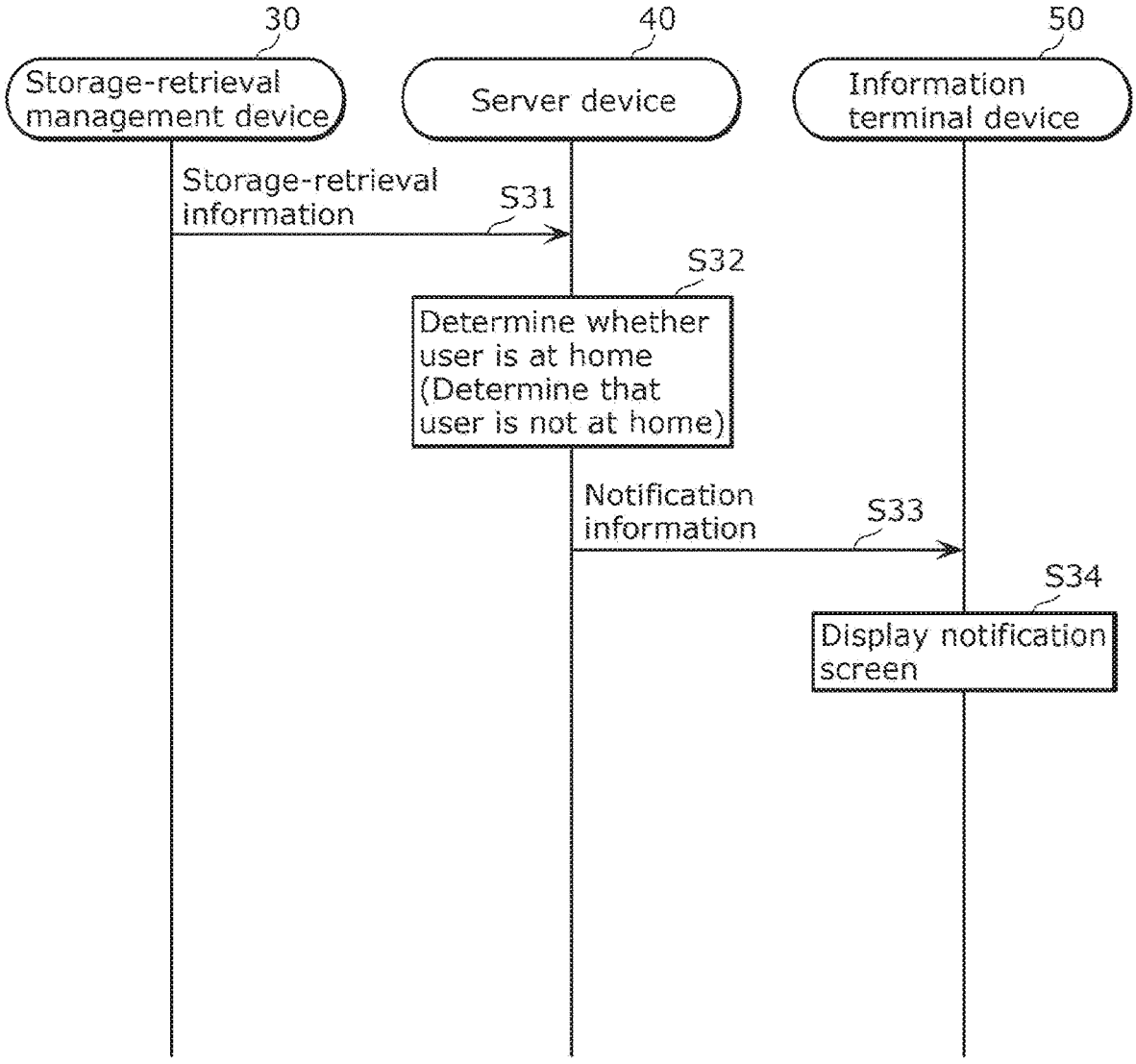

30
40
50
Storage-retrieval management device
Server device
Information terminal device
Storage-retrieval information
S31
S32
Determine whether user is at home (Determine that user is not at home)
Notification information
S33
S34
Display notification screen

FIG. 12

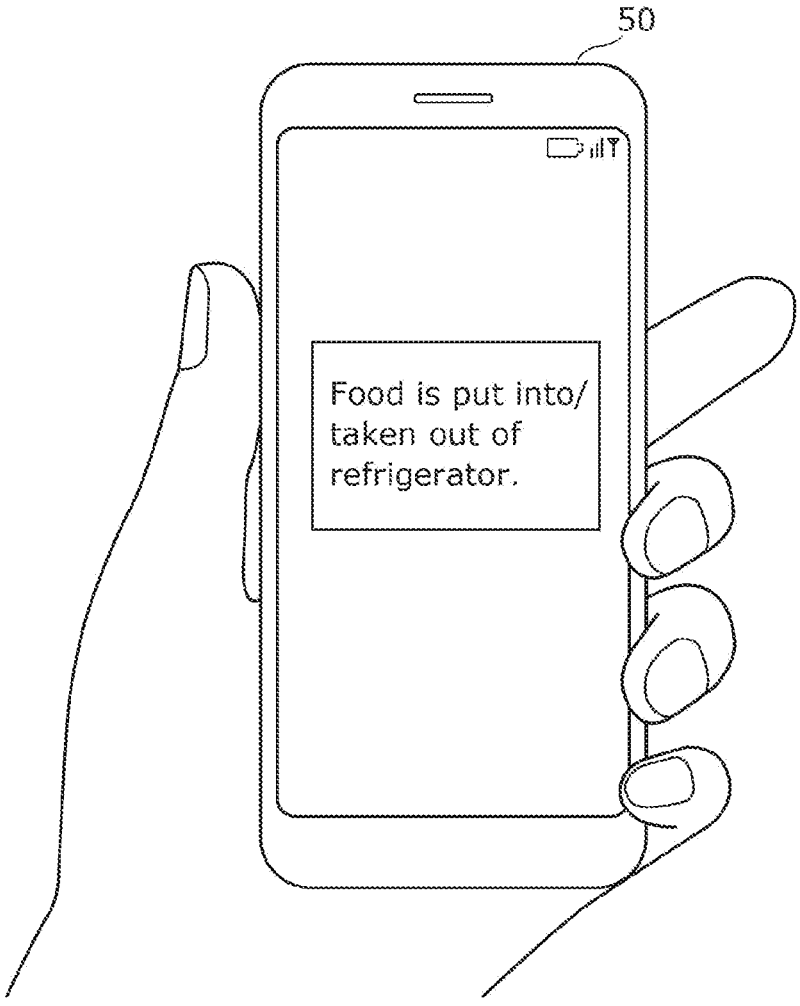


FIG. 13

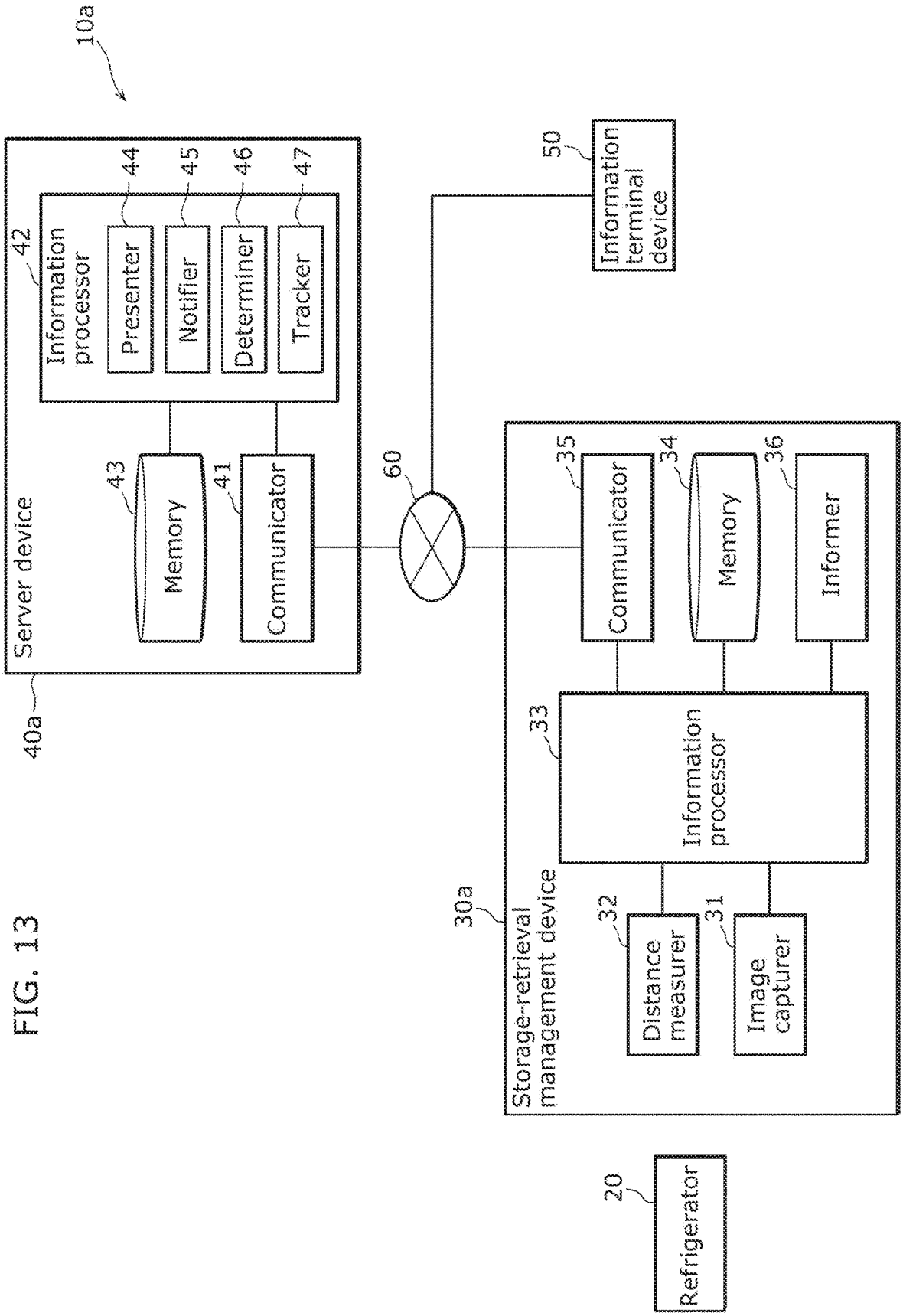

10a
Server device
40a
Information processor
42
Presenter
44
Notifier
45
Determiner
46
Tracker
47
Memory
43
Communicator
41
60
Information terminal device
50
Storage-retrieval management device
30a
Communicator
35
Memory
34
Informer
36
Information processor
33
Distance measurer
32
Image capturer
31
Refrigerator
20

FIG. 14

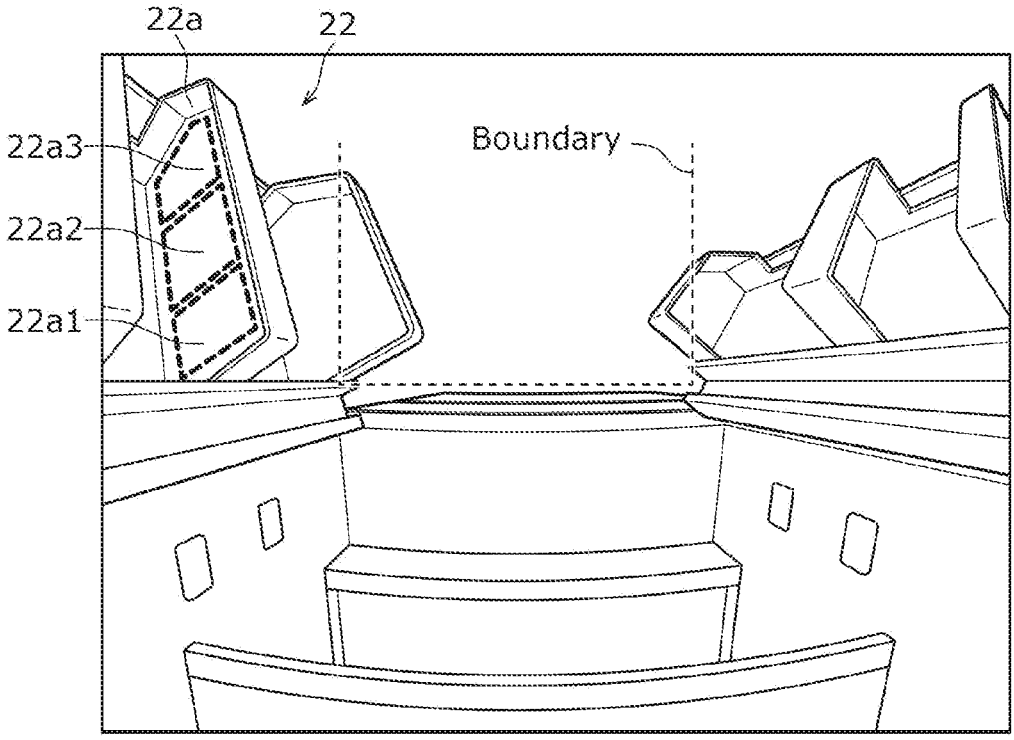


FIG. 15

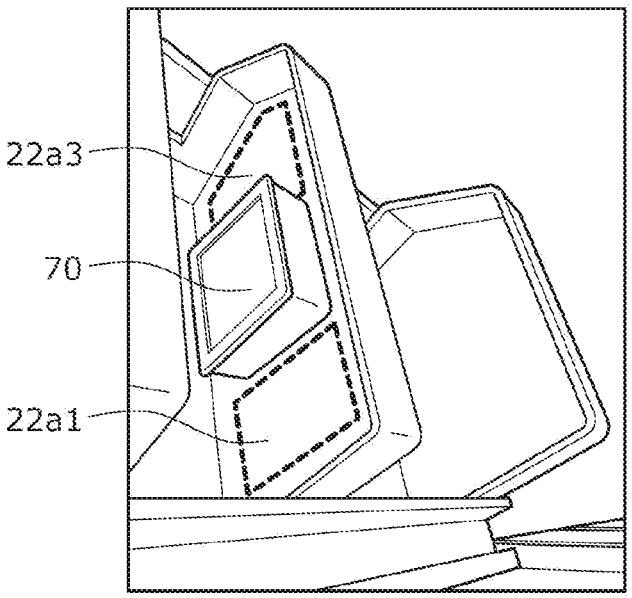


FIG. 16

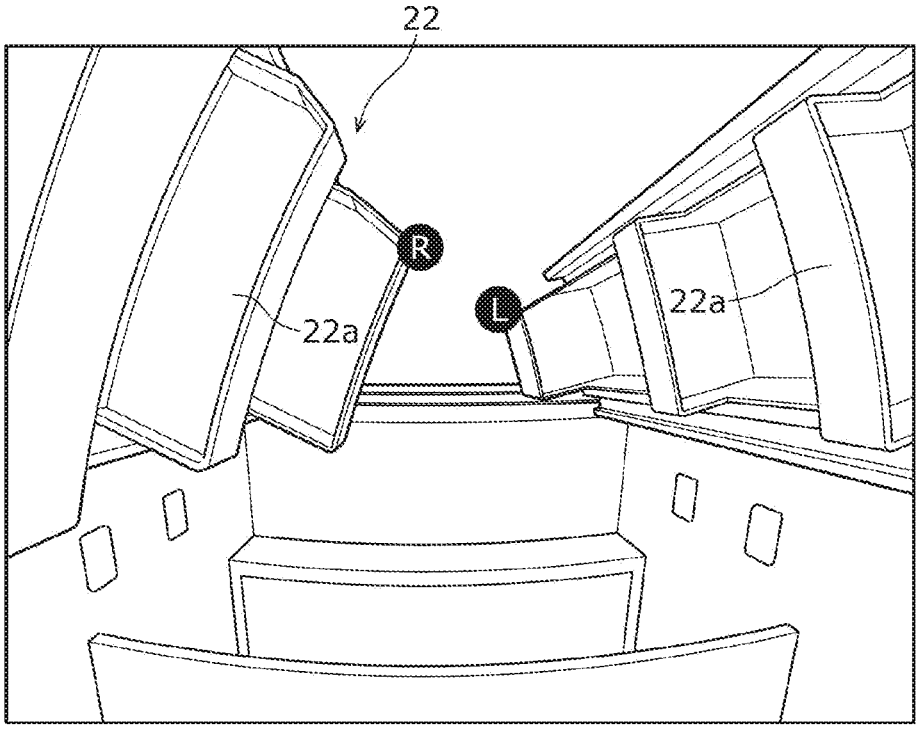


FIG. 17

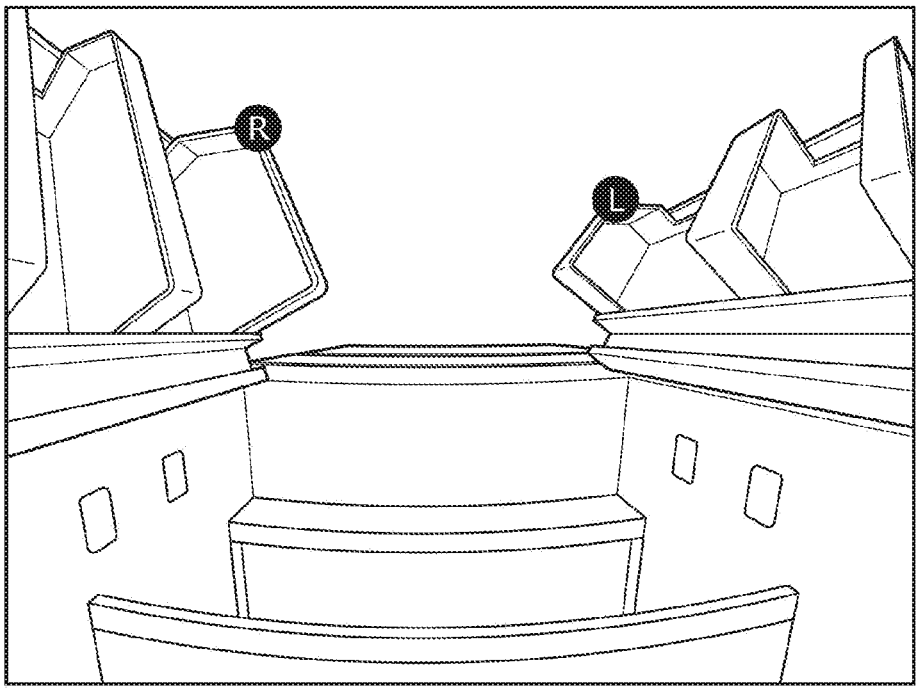


FIG. 18

Distance to right door	R	Opening angle of right door	Distance to left door	L	Opening angle of left door
Up to 5 cm (Closed state)	(x_1, y_1)	α_1	Up to 5 cm (Closed state)	(X_1, Y_1)	β_1
5 to 10 cm (Half-opened state)	:	:	5 to 10 cm (Half-opened state)	:	:
10 to 15 cm (Opened state)	:	:	10 to 15 cm (Opened state)	:	:
15 cm or more (Fully opened state)	:	:	15 cm or more (Fully opened state)	:	:

STORAGE-RETRIEVAL MANAGEMENT DEVICE, STORAGE-RETRIEVAL MANAGEMENT SYSTEM, AND STORAGE-RETRIEVAL MANAGEMENT METHOD

CROSS-REFERENCE OF RELATED APPLICATIONS

[0001] This application is the U.S. National Phase under 35 U.S.C. § 371 of International Patent Application No. PCT/JP2022/007100, filed on Feb. 22, 2022, which in turn claims the benefit of Japanese Patent Application No. 2021-028414, filed on Feb. 25, 2021, the entire disclosures of which applications are incorporated by reference herein.

TECHNICAL FIELD

[0002] The present disclosure relates to a storage-retrieval management device, a storage-retrieval management system, and a storage-retrieval management method.

BACKGROUND ART

[0003] Conventionally, technology that relates to a repository in which objects are stored has been proposed. Patent Literature (PTL) 1 discloses a storage-retrieval management system for refrigerators. The storage-retrieval management system disclosed in PTL 1 determines that objects are stored into or retrieved from a refrigerator using a learning model. The learning model outputs a result of storage/retrieval determination if information obtained by a sensor provided in the refrigerator is input.

CITATION LIST

Patent Literature

[0004] [PTL 1] Japanese Unexamined Patent Application Publication No. 2020-41761

SUMMARY OF INVENTION

Technical Problem

[0005] The present disclosure provides a storage-retrieval management device, a storage-retrieval management system, and a storage-retrieval management method with which storage positions in a repository at which objects are stored can be managed.

Solution to Problem

[0006] A storage-retrieval management device according to an aspect of the present disclosure includes: an image capturer that captures images each including markers as subjects from above a repository that includes a first storage structure and a second storage structure, the images showing a scene in which an object is put into or taken out of the repository, the markers being provided on the first storage structure and the second storage structure, the second storage structure being at a position different from a position of the first storage structure in a vertical direction; and a determiner that determines a storage position at which the object is stored, based on whether the markers included in the images are visible or hidden.

[0007] A storage-retrieval management system according to an aspect of the present disclosure includes: an image capturer that captures images each including markers as subjects from above a repository that includes a first storage structure and a second storage structure, the images showing a scene in which an object is put into or taken out of the repository, the markers being provided on the first storage structure and the second storage structure, the second storage structure being at a position different from a position of the first storage structure in a vertical direction; and a determiner that determines a storage position at which the object is stored, based on whether the markers included in the images are visible or hidden.

[0008] A storage-retrieval management method according to an aspect of the present disclosure includes: capturing images each including markers as subjects from above a repository that includes a first storage structure and a second storage structure, the images showing a scene in which an object is put into or taken out of the repository, the markers being provided on the first storage structure and the second storage structure, the second storage structure being at a position different from a position of the first storage structure in a vertical direction; and determining a storage position at which the object is stored, based on whether the markers included in the images are visible or hidden.

Advantageous Effects of Invention

[0009] A storage-retrieval management device, a storage-retrieval management system, and a storage-retrieval management method according to aspects of the present disclosure can manage storage positions in a repository at which objects are stored.

BRIEF DESCRIPTION OF DRAWINGS

[0010] FIG. **1** is a block diagram illustrating a functional configuration of a storage-retrieval management system according to an embodiment.

[0011] FIG. **2** is an external view of a refrigerator and a storage-retrieval management device included in the storage-retrieval management system according to the embodiment.

[0012] FIG. **3** is a flowchart showing Operation Example 1 of the storage-retrieval management system according to the embodiment.

[0013] FIG. **4** illustrates an example of a video captured by an image capturer.

[0014] FIG. **5** illustrates an example of food management information.

[0015] FIG. **6** is a diagram for describing a determination method when food is stored onto an upper shelf.

[0016] FIG. **7** is a diagram for describing a determination method when food is stored onto a lower shelf.

[0017] FIG. **8** illustrates a video showing the refrigerator with a drawer in a pulled-out state, which is captured by the image capturer.

[0018] FIG. **9** is a sequence diagram of Operation Example 2 of the storage-retrieval management system according to the embodiment.

[0019] FIG. **10** illustrates an example of a display screen showing details of food management information.

[0020] FIG. **11** is a sequence diagram of Operation Example 3 of the storage-retrieval management system according to the embodiment.

[0021] FIG. **12** illustrates an example of a notification screen.

[0022] FIG. **13** is a block diagram illustrating a functional configuration of a storage-retrieval management system according to a variation.

[0023] FIG. **14** illustrates an example of setting region markers.

[0024] FIG. **15** illustrates a state in which food in a container is stored in a door compartment.

[0025] FIG. **16** is a first diagram illustrating a state in which doors are opened.

[0026] FIG. **17** is a second diagram illustrating a state in which the doors are opened.

[0027] FIG. **18** illustrates an example of setting information.

DESCRIPTION OF EMBODIMENTS

[0028] The following gives a specific description of embodiments with reference to the drawings. Note that the embodiments described below each show a general or specific example. The numerical values, shapes, materials, elements, the arrangement and connection of the elements, steps, the processing order of the steps, and others indicated in the following embodiments are examples, and therefore are not intended to limit the present disclosure. Further, among the elements in the following embodiments, elements not recited in any of the independent claims are described as optional elements.

[0029] Note that the diagrams are schematic diagrams, and do not necessarily provide strict illustration. In the drawings, the same reference sign is given to a substantially same element, and a redundant description thereof may be omitted or simplified.

Embodiment

[Configuration]

[0030] First, a configuration of a storage-retrieval management system according to an embodiment is to be described. FIG. **1** is a block diagram illustrating a functional configuration of the storage-retrieval management system according to the embodiment.

[0031] Storage-retrieval management system **10** illustrated in FIG. **1** is a system for managing food stored in refrigerator **20**. Storage-retrieval management system **10** includes refrigerator **20**, storage-retrieval management device **30**, server device **40**, and information terminal device **50**.

[0032] Refrigerator **20** is an example of a repository, and is provided in, for instance, a house of a user to refrigerate food. FIG. **2** is an external view of refrigerator **20** (and storage-retrieval management device **30**). As illustrated in FIG. **2**, refrigerator **20** includes main body **21**, doors **22** for access to first storage space **23** inside main body **21**, shelves **24** provided in first storage space **23**, and drawers **25**. By opening door(s) **22**, refrigerator **20** is brought into a state in which food items can be placed on shelves **24** (that is, food can be stored in first storage space **23**). Furthermore, by opening door(s) **22**, refrigerator **20** is brought into a state in which food items can be stored in door compartments **22***a* provided inside of each door **22**. By opening drawer **25**, refrigerator **20** can be brought into a state in which food can be stored in second storage space **26** in drawer **25**. In the example in FIG. **2**, refrigerator **20** includes two doors **22** that cover first storage space **23**, but nevertheless, single door **22** may cover first storage space **23**.

[0033] Storage-retrieval management device **30** is attached onto, for example, a top surface of refrigerator **20**, and performs information processing for managing food stored in refrigerator **20**. Storage-retrieval management device **30** is retrofitted onto existing refrigerator **20**, for example, but may be provided in refrigerator **20**. Thus, storage-retrieval management device **30** may be a device separate from refrigerator **20**, or may be a device manufactured integrally with refrigerator **20**. As illustrated in FIG. **1**, storage-retrieval management device **30** includes image capturer **31**, distance measurer **32**, information processor **33**, memory **34**, communicator **35**, and informer **36**.

[0034] Image capturer **31** captures, from above refrigerator **20**, a video showing a scene in which food is put into or taken out of refrigerator **20**. Thus, image capturer **31** captures, from above refrigerator **20**, a video of refrigerator **20** with door(s) **22** in an open state, for example. The video includes, as subjects, doors **22**, door compartments **22***a*, first storage space **23**, shelves **24**, drawers **25**, and a floor of the room space in front of refrigerator **20**. Image capturer **31** is implemented by, for example, a camera that includes a fisheye lens, but may be implemented by a camera that includes a normal lens.

[0035] Note that image capturer **31** may generate a plurality of images (still images) by capturing a scene in which an object is put into or taken out of refrigerator **20** at preset time intervals, and thus does not necessarily need to capture a video. Image capturer **31** is attached to a casing of storage-retrieval management device **30**, but may be attached to refrigerator **20** apart from the casing of storage-retrieval management device **30**. Thus, image capturer **31** may be retrofitted onto refrigerator **20**. In this case, image capturer **31** may include a magnet, a suction cup, or a clip, for instance, as a structure with which image capturer **31** can be retrofitted onto refrigerator **20**.

[0036] From above refrigerator **20**, distance measurer **32** measures a distance from distance measurer **32** to each door **22**. Thus, distance measurer **32** measures degrees to which doors **22** are opened. Distance measurer **32** is implemented by an infrared distance measurer sensor, for example. Distance measurer **32** can separately measure a distance from distance measurer **32** to right door **22** and a distance from distance measurer **32** to left door **22**.

[0037] Note that as described later, distance measurer **32** is used to determine whether doors **22** are open or closed. Storage-retrieval management device **30** may include another sensor for determining whether doors **22** are open or closed, such as an angular sensor instead of distance measurer **32**. A sensor for determining whether doors **22** are open or closed may be included in refrigerator **20**, and in this case, storage-retrieval management device **30** may not include a sensor for determining whether doors **22** are open or closed.

[0038] Information processor **33** performs information processing for managing food stored in refrigerator **20**. Information processor **33** is implemented by a microcomputer, for example, but may be implemented by a processor or a dedicated circuit. Information processor **33** includes determiner **37**, tracker **38**, and setter **39**, as functional elements. Functions of determiner **37**, tracker **38**, and setter **39** are realized by, for example, the microcomputer included in information processor **33**, for instance, executing a com-

puter program stored in memory **34**. Details of the functions of determiner **37**, tracker **38**, and setter **39** will be described later.

[0039] Memory **34** is a storage device that stores therein a computer program executed by information processor **33** and various information items necessary for the above-stated information processing (such as setting information and food management information described later). Memory **34** is implemented by a semiconductor memory, for example.

[0040] Communicator **35** is a communication circuit for storage-retrieval management device **30** to communicate with server device **40** via wide-area communication network **60**. Communicator **35** is, for example, a wireless communication circuit that performs wireless communication, but may be a wired communication circuit that performs wired communication. A communication standard of the communication performed by communicator **35** is not particularly limited.

[0041] Informer **36** gives notice when a type of food put into and taken out of refrigerator **20** cannot be determined. Informer **36** is implemented by a loudspeaker or a buzzer, for instance, and gives notice by outputting sound, but may be implemented by a light emitting element such as a light emitting diode (LED) and may give notice by emitting light.

[0042] Server device **40** is a computer located outside of a building in which refrigerator **20** is placed, and is a cloud server, specifically. Server device **40** performs information processing for presenting information related to food stored in refrigerator **20**. Server device **40** is an example of a notification device, and performs information processing for informing information related to food stored in refrigerator **20**. Server device **40** includes communicator **41**, information processor **42**, and memory **43**.

[0043] Communicator **41** is a communication circuit for server device **40** to communicate with storage-retrieval management device **30** and information terminal device **50** via wide-area communication network **60**. Communicator **41** is, for example, a wired communication circuit that performs wired communication, but may be a wireless communication circuit that performs wireless communication. A communication standard of the communication performed by communicator **41** is not particularly limited.

[0044] Information processor **42** performs information processing for presenting or notifying information related to food stored in refrigerator **20**. Information processor **42** is implemented by a microcomputer, for example, but may be implemented by a processor or a dedicated circuit. Information processor **42** includes presenter **44** and notifier **45**, as functional elements. Functions of presenter **44** and notifier **45** are realized by, for example, the microcomputer included in information processor **42**, for instance, executing a computer program stored in memory **43**. Details of the functions of presenter **44** and notifier **45** will be described later.

[0045] Memory **43** is a storage device that stores therein a computer program executed by information processor **42** and various information items necessary for the above-stated information processing. Memory **43** is implemented by a semiconductor memory, for example.

[0046] Information terminal device **50** is possessed by the user. The user uses information terminal device **50** in order to receive notification from server device **40**. Information terminal device **50** is a portable information terminal device such as a smartphone or a tablet terminal device, but may be a desktop information terminal device such as a personal computer.

Operation Example 1

[0047] Next, operation for managing storage and retrieval of food is to be described as Operation Example 1 of storage-retrieval management system **10**. FIG. **3** is a flowchart showing Operation Example 1 of storage-retrieval management system **10**.

[0048] First, when determiner **37** determines that at least one of two doors **22** is opened, based on a result of measurement by distance measurer **32** (S**11**), image capturer **31** is activated and starts capturing a video (S**12**). FIG. **4** illustrates an example of a video captured by image capturer **31**. As illustrated in FIG. **4**, an image capturing area of image capturer **31** includes main body **21** (first storage space **23**), inner sides of two doors **22** (door compartments **22***a*), and upper shelf **24***a* and lower shelf **24***b* provided in first storage space **23**. Note that FIG. **4** also illustrates a boundary (a broken line) used to determine whether food is stored and whether food is retrieved. This boundary is not a line captured by image capturer **31**, and is a virtual line.

[0049] Next, tracker **38** detects food captured in the video (S**13**), and tracks the detected food (S**14**). To detect food, various existing algorithms such as Regions with Convolution Neural Networks (R-CNN) are used. Tracker **38** detects food (hereinafter also referred to as a tracking target) also in a frame (also referred to as a current frame) that comes subsequent to a frame (hereinafter, also referred to as a previous frame) in which the food detected in step S**13**, for example, is captured. Tracker **38** determines, out of food items captured in the current frame, food at a position closest to a position of the tracking target in the previous frame, as the tracking target that has been moved. By repeating such processes, tracker **38** can track the food detected in step S**13**.

[0050] Note that tracker **38** may further extract an image feature amount of the food detected in step S**13**, and track the food using the image feature amount as auxiliary information. Tracker **38** may determine a moved position of the tracking target, based on, for example, a distance between the food detected in the current frame and the tracking target, and a similarity between the image feature amount detected in the current frame and that of the tracking target. Accordingly, the accuracy of tracking food can be improved.

[0051] Such a method for tracking food is an example, and another existing algorithm may be used to track food.

[0052] Next, determiner **37** determines whether food is stored or whether food is retrieved (S**15**). Determiner **37** determines that food being tracked is retrieved when the food is moved from refrigerator **20** to the indoor space beyond the boundary in the video. Determiner **37** determines that food that is a tracking target is stored when the food is moved from the indoor space to refrigerator **20** beyond the boundary in the video. Note that the boundary is predetermined empirically or experimentally.

[0053] Next, determiner **37** determines a type of the food that is stored or retrieved (S**16**). Determiner **37** determines a type of the food using a machine learning model, for example. Examples of types of food include a drink, a vegetable, and meat, for instance, but the types may be more finely classified. Note that the type of food may be determined at the same time when the food is detected in step S**13**, and in this case, step S**16** can be omitted.

[0054] Next, determiner **37** determines a storage position at which food is stored (S**17**). As illustrated in FIG. **4**, determiner **37** determines the storage position of food, based on whether first markers **27***a*, second markers **27***b*, and third markers **27***c* that are captured in the video are visible or hidden. First markers **27***a* are provided on upper shelf **24***a*, second markers **27***b* are provided on lower shelf **24***b*, and third markers **27***c* are provided on bottom portions of door compartments **22***a*. A method for determining the storage position of food in step S**17** is to be described later in detail.

[0055] Next, determiner **37** updates food management information stored in memory **34**, based on results of determinations in steps S**15** to S**17** (S**18**). FIG. **5** illustrates an example of food management information. The food management information shows a breakdown of food items stored in refrigerator **20**. As illustrated in FIG. **5**, the food management information shows types and quantities of food items at storage positions, for example. When determiner **37** determines that a drink is retrieved from upper shelf **24***a* in steps S**15** to S**17**, determiner **37** decrements the quantity of drinks on upper shelf **24***a* in the food management information by one. Further, when determiner **37** determines that a vegetable is stored onto lower shelf **24***b* in steps S**15** to S**17**, determiner **37** increments the quantity of vegetables on lower shelf **24***b* in the food management information by one.

[0056] After that, when determiner **37** determines that two doors **22** are both closed, based on the results of measurement by distance measurer **32** (S**19**), operation ends.

[0057] As described above, storage-retrieval management system **10** (storage-retrieval management device **30**) can determine whether or not food captured in a video is stored into or retrieved from refrigerator **20** (whether food is stored into refrigerator **20** or whether food is retrieved from refrigerator **20**), based on whether the food is moved beyond the boundary that is set.

[0058] Note that if determination of the type of food has failed in step S**16**, that is, when the type of food cannot be determined, determiner **37** may inform that determination of a type of food is impossible, using informer **36**. For example, if informer **36** is implemented by a loudspeaker, informer **36** outputs an audio message, for instance, conveying that the type of food cannot be determined. If informer **36** is implemented by a light emitting element, informer **36** informs that the type of food cannot be determined, by emitting light.

[0059] In this manner, if the determination of a type of food has failed and that failure is informed, the user can cope with the failure by manually correcting the food management information.

[Detail 1 of Method for Determining Storage Position]

[0060] Next, a method for determining a storage position at which food is stored in step S**17** is to be described in detail. First, first markers **27***a*, second markers **27***b*, and third markers **27***c* are to be described.

[0061] First markers **27***a* are two-dimensional codes provided on the top surface of upper shelf **24***a* in first storage space **23**. First markers **27***a* are aligned in the width direction of refrigerator **20**, on a portion of shelf **24***a* closer to the user (a forward portion of refrigerator **20**). Determiner **37** performs image processing on a video, and consequently can recognize first markers **27***a* as digital data. First markers **27***a* indicate digital data items different from one another, for example, but may indicate the same digital data item.

[0062] Second markers **27***b* are two-dimensional codes provided on the top surface of lower shelf **24***b* in first storage space **23**. Second markers **27***b* are aligned in the width direction of refrigerator **20**, on a portion of shelf **24***b* closer to the user (a forward portion of refrigerator **20**). Determiner **37** performs image processing on a video, and consequently can recognize second markers **27***b* as digital data. Second markers **27***b* indicate digital data items different from one another, for example, but may indicate the same digital data item.

[0063] Third markers **27***c* are two-dimensional codes provided on the bottom portions of door compartments **22***a*. One third marker **27***c* may be provided on one door compartment **22***a*, or plural third markers **27***c* may be provided on one door compartment **22***a*. Determiner **37** performs image processing on a video, and consequently can recognize third markers **27***c* as digital data. Third markers **27***c* indicate digital data items different from one another, for example. For example, third markers **27***c* may indicate different digital data items for different doors **22**. Thus, third markers **27***c* provided on right door **22** may indicate a different digital data item from the digital data item indicated by third markers **27***c* provided on left door **22**. Third markers **27***c* may indicate different digital data items for different door compartments **22***a*.

[0064] Such arrangement of first markers **27***a*, second markers **27***b*, and third markers **27***c* is prestored in memory **34**.

[0065] Next, a method for determining storage positions of food items, based on whether first markers **27***a*, second markers **27***b*, and third markers **27***c* are visible or hidden. FIG. **6** is a diagram for describing a determination method when food is stored onto upper shelf **24***a*. FIG. **6** illustrates a video captured by image capturer **31**.

[0066] As illustrated in FIG. **6**, when food is stored onto upper shelf **24***a*, at least one of first markers **27***a* provided on upper shelf **24***a* is at least temporarily hidden by the food and cannot be seen. Thus, when at least one first marker **27***a* is hidden when food is stored, determiner **37** determines that a storage position of the food is on shelf **24***a*. Even if first markers **27***a* are visible after the food is placed on shelf **24***a*, determiner **37** determines that a storage position of the stored food is on upper shelf **24***a*, based on at least one first marker **27***a* being made invisible while the food is stored thereonto. Determiner **37** determines that the storage position of the food is on shelf **24***a* when at least one first marker **27***a* is hidden, irrespective of whether one or more second markers **27***b* are hidden. Determiner **37** determines which region of upper shelf **24***a* includes a storage position of the food, based on which of first markers **27***a* is hidden.

[0067] Although not illustrated, the same applies to when food is retrieved from upper shelf **24***a*. If at least one first marker **27***a* is hidden when food is retrieved, determiner **37** determines that a storage position of the food is on shelf **24***a*. Determiner **37** determines that the storage position of the food retrieved was on upper shelf **24***a*, based on at least one first marker **27***a* being made invisible while the food is retrieved therefrom.

[0068] In contrast, FIG. **7** is a diagram for describing a determination method when food is stored onto lower shelf **24***b*. FIG. **7** illustrates a video captured by image capturer **31**. As illustrated in FIG. **7**, when food is stored onto lower shelf **24***b*, at least one of second markers **27***b* provided on lower shelf **24***b* is at least temporarily hidden by the food

and cannot be seen while first markers **27***a* provided on upper shelf **24***a* remain visible. Thus, when first markers **27***a* remain visible and at least one second marker **27***b* is hidden when food is stored, determiner **37** determines that a storage position of the food is on shelf **24***b*. Even if second markers **27***b* are visible after the food is placed on shelf **24***b*, determiner **37** determines that a storage position of the stored food is on shelf **24***b*, based on at least one second marker **27***b* being made invisible while the food is stored thereonto. Determiner **37** determines which region of shelf **24***b* includes a storage position of the food, based on which of second markers **27***b* is hidden.

[0069] Although not illustrated, the same applies to when food is retrieved from lower shelf **24***b*. If first markers **27***a* remain visible and at least one second marker **27***b* is hidden when food is retrieved, determiner **37** determines that a storage position of the food is on shelf **24***b*. Determiner **37** determines that the storage position of the food retrieved was on shelf **24***b*, based on at least one second marker **27***b* being made invisible while the food is retrieved therefrom.

[0070] Next, a determination method when food items are stored into door compartments **22***a* is to be described. When food is stored into one of door compartments **22***a*, third marker **27***c* provided on the one of door compartments **22***a* is hidden and made invisible. Thus, if third marker **27***c* is hidden when food is stored, determiner **37** determines that a storage position of the stored food is on door compartment **22***a* provided with hidden third marker **27***c*. As described above, if third marker **27***c* indicates different digital data items for different doors **22** or for door compartments **22***a*, determiner **37** can determine the storage position of the food more accurately.

[0071] In contrast, if food is retrieved from one of door compartments **22***a*, third marker **27***c* provided on the one of door compartments **22***a* and made invisible by the food appears. Thus, if third marker **27***c* appears when the food is retrieved, determiner **37** determines that a storage position of the retrieved food was on door compartment **22***a* provided with third marker **27***c* that has appeared.

[0072] As described above, determiner **37** can determine the storage position of food, based on whether a marker is visible or hidden in a video. Specifically, determiner **37** can determine which one of shelf **24***a*, shelf **24***b*, or door compartment **22***a* includes the storage position of food.

[0073] Note that when a marker is made visible or hidden in an unexpected pattern, determiner **37** may fail to determine a storage position. In view of this, informer **36** may give notice when determination of the storage position of food in step **S17** has failed. By giving such notice, the user can cope with the failure by manually correcting the food management information.

[Detail 2 of Method for Determining Storage Position]

[0074] Determiner **37** can determine whether a storage position of food is in first storage space **23** covered with door **22** or second storage space **26** in drawer **25**. FIG. **8** illustrates a video showing refrigerator **20** with drawer **25** in a pulled-out state, which is captured by image capturer **31**.

[0075] As illustrated in FIG. **8**, fourth markers **27***d* are two-dimensional codes provided on a top surface of a front panel of drawer **25**. Fourth markers **27***d* are aligned in the width direction of refrigerator **20**. Determiner **37** performs image processing on a video, and consequently can recognize fourth markers **27***d* as digital data. Fourth markers **27***d* indicate digital data items different from one another, for example, but may indicate the same digital data item.

[0076] Determiner **37** may determine in which of first storage space **23** or second storage space **26** a storage position of food is, based on whether such fourth markers **27***d* or second markers **27***b* are visible or hidden, for example. Note that a description of the determination method as below is given on the assumption that second markers **27***b* are provided on a bottom portion (more specifically, on a bottom surface) of first storage space **23**. Second markers **27***b* may be provided close to the bottom portion of first storage space **23**, and may be provided on shelf **24***b* similarly to the above description, for example.

[0077] For example, when food is stored into first storage space **23**, at least one of second markers **27***b* provided on a bottom surface of first storage space **23** is at least temporarily hidden and made invisible by the food. Thus, when at least one second marker **27***b* is hidden when food is stored into, determiner **37** determines that a storage position of the food is in first storage space **23**. Even if second markers **27***b* are visible after the food is stored into first storage space **23**, determiner **37** determines that a storage position of the stored food is in first storage space **23**, based on at least one second marker **27***b* being made invisible while the food is stored thereinto. Determiner **37** determines that the storage position of the food is in first storage space **23** when at least one second marker **27***b* is hidden, irrespective of whether one or more fourth markers **27***d* are hidden. Determiner **37** can determine (estimate) which region of first storage space **23** includes a storage position of food, based on which of second markers **27***b* is hidden.

[0078] Note that the same applies to the case where food is retrieved from first storage space **23**. If at least one second marker **27***b* is hidden when food is retrieved, determiner **37** determines that a storage position of the food is in first storage space **23**. Determiner **37** determines that the storage position of the food retrieved was in first storage space **23**, based on at least one second marker **27***b* being made invisible while the food is retrieved therefrom.

[0079] In contrast, when food is stored into second storage space **26**, at least one of fourth markers **27***d* is at least temporarily hidden and made invisible by the food while second markers **27***b* remain visible. Thus, when second markers **27***b* remain visible and at least one fourth marker **27***d* is hidden when food is stored, determiner **37** determines that a storage position of the food is in second storage space **26**. Even if fourth markers **27***d* are visible after the food is stored into second storage space **26**, determiner **37** determines that a storage position of the stored food is in second storage space **26**, based on at least one fourth marker **27***d* being made invisible while the food is stored thereinto. Determiner **37** can determine (estimate) which region of second storage space **26** includes a storage position of food, based on which of fourth markers **27***d* is hidden.

[0080] Note that the same applies to the case where food is retrieved from second storage space **26**. If second markers **27***b* remain unhidden and at least one fourth marker **27***d* is hidden when food is retrieved, determiner **37** determines that a storage position of the food is in second storage space **26**. Determiner **37** determines that the storage position of the food retrieved was in second storage space **26**, based on at least one fourth marker **27***d* being made invisible while the food is retrieved therefrom.

[0081] As described above, determiner **37** can determine in which one of first storage space **23** or second storage space **26** the storage position of food is, based on whether a marker is visible or hidden in a video.

Operation Example 2

[0082] Next, as Operation Example 2 of storage-retrieval management system **10**, operation for presenting food stored in refrigerator **20** is to be described. FIG. **9** is a sequence diagram of Operation Example 2 of storage-retrieval management system **10**.

[0083] Communicator **35** of storage-retrieval management device **30** transmits food management information to server device **40** (S**21**). Communicator **41** of server device **40** receives the food management information, and presenter **44** stores the received food management information into memory **43** (S**22**). Communicator **35** of storage-retrieval management device **30** transmits food management information to server device **40** each time food storage determination or food retrieval determination is made, for example. Alternatively, communicator **35** of storage-retrieval management device **30** transmits food management information to server device **40** each time opened door **22** is closed. Accordingly, the updated food management information is stored into memory **43** of server device **40**. Note that food management information may be transmitted from storage-retrieval management device **30** to server device **40** periodically, such as once in a predetermined time.

[0084] On the other hand, when the user performs, on information terminal device **50** from, for instance, a place away from home, a predetermined operation for checking food stored in refrigerator **20** (details of food management information), information terminal device **50** receives such a predetermined operation (S**23**), and transmits a presentation request to server device **40**, based on the received predetermined operation (S**24**).

[0085] Communicator **41** of server device **40** receives the presentation request. Presenter **44** transmits, to information terminal device **50**, presentation information for presenting details of the food management information stored in memory **43**, based on the received presentation request (S**25**). More specifically, communicator **41** transmits the presentation information.

[0086] Information terminal device **50** receives the presentation information, and causes a display included in information terminal device **50** to show a display screen showing details of the food management information, based on the received presentation information (S**26**). FIG. **10** illustrates an example of a display screen showing details of food management information.

[0087] In this manner, the user of storage-retrieval management system **10** can check food stored in refrigerator **20** in the user's house from the place away from home, for instance.

Operation Example 3

[0088] Next, as Operation Example 3 of storage-retrieval management system **10**, an operation for notifying the user that food is stored into or retrieved from refrigerator **20** when the user is not at home is to be described. FIG. **11** is a sequence diagram of Operation Example 3 of storage-retrieval management system **10**.

[0089] Communicator **35** of storage-retrieval management device **30** transmits storage-retrieval information to server device **40** each time food storage determination or food retrieval determination is made, for example (S**31**). Storage-retrieval information is an example of information indicating that food is put into or taken out of refrigerator **20**.

[0090] Communicator **41** of server device **40** receives storage-retrieval information, and notifier **45** determines whether the user is at home (S**32**). Stated differently, notifier **45** determines whether storage-retrieval information is received during a period in which the user is not adjacent to refrigerator **20**.

[0091] For example, information terminal device **50** includes a position measurer such as a Global Positioning System (GPS) module, and periodically transmits position information to server device **40**. In this case, notifier **45** can determine whether the user is at home, based on the received position information. Note that the position (coordinates) of the user's house is registered in memory **43** in advance.

[0092] Instead of a method that uses position information, the user may report to server device **40** that the user is not at home by operating information terminal device **50**. In this case, notifier **45** can regard execution of an away-from-home mode based on the above report as implying that the user is not at home.

[0093] When notifier **45** determines that the user is not at home, notifier **45** transmits notification information to information terminal device **50** (S**33**). More specifically, communicator **41** transmits notification information.

[0094] Information terminal device **50** receives the notification information, and displays a notification screen, based on the received notification information (S**34**). FIG. **12** illustrates an example of a notification screen. On the other hand, when notifier **45** has determined in step S**32** that the user is at home (has not gone out), processing in steps S**33** and S**34** is not performed.

[0095] In this manner, storage-retrieval management system **10** notifies information terminal device **50** possessed by the user when storage-retrieval information indicating that an object is stored into refrigerator **20** or an object is retrieved from refrigerator **20** during a period in which the user is not adjacent to refrigerator **20**.

[0096] Accordingly, the user can be aware that food is put into or taken out of refrigerator **20** during a period in which the user is not adjacent to refrigerator **20**.

[Variation 1]

[0097] In the above embodiment, processing from detection of food (step S**13**) to update of food management information (step S**18**) is performed by storage-retrieval management device **30**, but may be performed by server device **40**. FIG. **13** is a block diagram illustrating a functional configuration of a storage-retrieval management system according to Variation 1.

[0098] As illustrated in FIG. **13**, storage-retrieval management system **10***a* includes refrigerator **20**, storage-retrieval management device **30***a*, server device **40***a*, and information terminal device **50**. A difference from storage-retrieval management system **10** is that not storage-retrieval management device **30***a*, but server device **40***a* (more specifically, information processor **42**) includes determiner **46** and tracker **47**. Determiner **46** is an element having a substantially same

function as that of determiner **37**, whereas tracker **47** is an element having a substantially same function as that of tracker **38**.

[0099] In such storage-retrieval management system **10***a*, server device **40***a* obtains, from storage-retrieval management device **30***a*, results of measurement by distance measurer **32** and videos captured by image capturer **31**, for instance, to perform processing from detection of food (step S**13**) to update of food management information (step S**18**).

[0100] Note that part of the processing from detection of food (step S**13**) to update of food management information (step S**18**) may be performed by storage-retrieval management device **30***a*, and the remaining part thereof may be performed by server device **40***a*.

[Variation 2]

[0101] In the above embodiment, the storage position of food in the vertical direction is determined, based on first markers **27***a* provided on shelf **24***a*, second markers **27***b* provided on shelf **24***b*, and fourth markers **27***d* provided on drawers **25**. However, the storage position of food in the vertical direction may be determined, using an edge of shelf **24***a*, an edge of shelf **24***b*, and edges of drawers **25**, instead of such markers. The edges here are the ones closer to openings of refrigerator **20** (edges closer to the user standing in front of refrigerator **20**).

[0102] Edges can be detected (set) by setter **39** performing image processing on a video, for example. Any of existing algorithms may be used to detect edges. Furthermore, the user may set edges (more specifically, positions of pixels corresponding to edges in a video) after a positional relation between storage-retrieval management device **30** (image capturer **31**) and refrigerator **20** is determined. In this case, for example, information terminal device **50** is used as a user interface. Note that a description has been given assuming that information terminal device **50** communicates with storage-retrieval management device **30** via wide-area communication network **60**. Yet, information terminal device **50** may communicate with storage-retrieval management device **30** via a local communication network when information terminal device **50** is used as a user interface. Note that information processing with regard to detecting (setting) edges may be performed by setter **39**.

[0103] A method for determining a storage position of food in the vertical direction using edges is similar to the method described in the above embodiment. The term "marker" in the above embodiment may be replaced with "edge" as appropriate.

[0104] Thus, storage-retrieval management device **30** includes: image capturer **31** that captures from above refrigerator **20** that includes a first storage structure and a second storage structure, images each including, as subjects, edges closer to an opening of refrigerator **20**, the images showing a scene in which an object is put into or taken out of refrigerator **20**, the edges being edges of the first storage structure and the second storage structure, the second storage structure being at a position different from a position of the first storage structure in a vertical direction; and determiner **37** that determines a storage position at which the object is stored, based on whether the edges included in the images are visible or hidden. Each of the first storage structure and the second storage structure is any of shelf **24***a*, shelf **24***b*, and drawer **25**, for example.

[0105] Such storage-retrieval management device **30** can manage storage positions of objects in refrigerator **20**.

[Variation 3: Outline]

[0106] Storage-retrieval management system **10** (storage-retrieval management device **30**) may set a boundary along contours of main body **21** and doors **22**, and determine whether or not food captured in a video is stored into or retrieved from refrigerator **20** (whether food is stored into refrigerator **20** or whether food is retrieved from refrigerator **20**), based on whether the food is moved beyond the boundary that is set. Storage-retrieval management system **10** can improve accuracy of determination as to whether food is stored into or retrieved from refrigerator **20**, by setting a boundary along the contours of main body **21** and doors **22**, as compared with the case where boundaries irrelevant to the contours are set. Storage-retrieval management system **10** can accurately determine storage of food into and retrieval of food from door compartments **22***a*, in particular. Note that the boundary is predetermined empirically or experimentally.

[0107] Similarly, storage-retrieval management system **10** (storage-retrieval management device **30**) may set region markers **22***a***1**, **22***a***2**, and **22***a***3** that divide a bottom surface of door compartment **22***a* provided on the inner side of one of two doors **22** into predetermined regions in a video. FIG. **14** illustrates an example of setting region markers **22***a***1**, **22***a***2**, and **22***a***3**. Note that FIG. **14** illustrates the case where the bottom portion of door compartment **22***a* is divided into three, but the present embodiment is not limited thereto.

[0108] Further, storage-retrieval management system **10** (storage-retrieval management device **30**) can set in advance region markers **22***a***1**, **22***a***2**, and **22***a***3** that divide the bottom surface of door compartment **22***a* provided on the inner side of one of two doors **22** into predetermined regions, but the user can set such region markers. If the user sets the region markers, information terminal device **50**, for example, may be used as a user interface. Note that a description has been given assuming that information terminal device **50** communicates with storage-retrieval management device **30** via wide-area communication network **60**. Yet, information terminal device **50** may communicate with storage-retrieval management device **30** via a local communication network when information terminal device **50** is used as a user interface. Setter **39** performs information processing that relates to setting of region markers **22***a***1**, **22***a***2**, and **22***a***3**. Note that region markers **22***a***1**, **22***a***2**, and **22***a***3** are not the ones captured by image capturer **31**, but are virtual markers.

[0109] An operation example in which region markers **22***a***1**, **22***a***2**, and **22***a***3** are used is to be described below. Similarly to steps S**11** and S**12** in Operation Example 1, if determiner **37** determines that at least one of two doors **22** is opened, based on a result of measurement by distance measurer **32**, image capturer **31** is activated and starts capturing a video. Here, distance measurer **32** is implemented by an infrared distance measurer sensor, for example. Distance measurer **32** can separately measure a distance from distance measurer **32** to right door **22** and a distance from distance measurer **32** to left door **22**.

[0110] FIG. **14** described above illustrates an example of a video captured by image capturer **31**, and as illustrated in FIG. **14**, an image capturing area of image capturer **31** includes main body **21** (first storage space **23**) and the inside of two doors **22** (door compartments **22***a*). FIG. **14** also

illustrates a boundary (a broken line) used to determine whether food is stored into or retrieved from. This boundary is not the one captured by image capturer **31**, but is a virtual line.

[0111] Next, similarly to step S**17** in Operation Example 1, determiner **37** determines a storage position of food. As illustrated in FIG. **14**, determiner **37** determines a storage position of food, based on whether region markers **22***a***1**, **22***a***2**, and **22***a***3** set on a bottom portion of door compartment **22***a* are visible or invisible (whether food overlaps at least one of the region markers), which is captured in a video.

[0112] FIG. **15** illustrates a state in which food **70** in a container is stored in door compartment **22***a*. Three region markers **22***a***1**, **22***a***2**, and **22***a***3** are set on a bottom surface of door compartment **22***a*, yet food **70** is stored therein, overlapping region marker **22***a***2**. Determiner **37** can determine that food **70** is stored at a position of region marker **22***a***2**, based on the state of a bottom portion of door compartment **22***a* captured in a video showing that region markers **22***a***1** and **22***a***3** are visible but region marker **22***a***2** is hidden.

[Variation 3: Influence of Height of Food]

[0113] Note that in FIG. **15**, food (not illustrated) placed on region marker **22***a***3** may not be seen in an image captured by image capturer **31**, depending on the height of the food. However, as the opening angle of a door is decreased, the food placed on region marker **22***a***3** becomes visible. In view of this, determiner **37** may determine a storage position of food, at a plurality of opening angles of a door.

[Variation 3: Correction of Positions of Region Markers as Doors being Opened and Closed]

[0114] Setter **39** may dynamically change region markers **22***a***1**, **22***a***2**, and **22***a***3** according to degrees to which doors **22** are opened. FIG. **16** and FIG. **17** illustrate states in which doors **22** are opened. Here, the state illustrated in FIG. **17** shows that doors **22** are more widely opened than the state illustrated in FIG. **16**. In this manner, for example, opening angles of left and right doors may be detected in order to dynamically change region markers **22***a***1**, **22***a***2**, and **22***a***3** according to degrees to which doors **22** are opened.

[Variation 3: Opening Angles of Doors being Measured by Distance Measurer]

[0115] For example, memory **34** prestores therein setting information for setting region markers. FIG. **18** illustrates an example of setting information. Numerical values in the setting information in FIG. **18** are temporary numerical values for explanation.

[0116] In the setting information in FIG. **18**, a distance from distance measurer **32** to right door **22** and coordinates of point R provided on right door **22** are associated, and a distance from distance measurer **32** to left door **22** and coordinates of point L provided on left door **22** are associated. In the setting information, setter **39** can identify coordinates of points R and L that correspond to results of measurement by distance measurer **32**, can determine opening angles of doors **22**, based on the identified coordinates, and can set positions of region markers **22***a***1**, **22***a***2**, and **22***a***3** according to the opening angles of doors **22**. Note that in the setting information in FIG. **18**, the degrees to which doors **22** are opened are divided into four levels, but may be divided into five or more levels, or may be divided into three levels or less.

[0117] Note that in the present embodiment, one point R is provided on door **22** that is on the right when viewed from the user, and one point L is provided on door **22** that is on the left when viewed from the user. However, as long as the degrees to which doors **22** are opened can be identified, positions of points with which the degrees are to be measured and the number of such points may be determined as necessary.

[Variation 3: Opening Angles of Doors being Measured by Angular Sensor]

[0118] Alternatively, storage-retrieval management device **30** may include another sensor that measures degrees to which doors **22** are opened (opening angles), such as an angular sensor instead of distance measurer **32**. A sensor for measuring degrees to which doors **22** are opened may be included in refrigerator **20**, and in this case, storage-retrieval management device **30** may not include a sensor for measuring degrees to which doors **22** are opened.

[0119] As described above, setter **39** can set region markers **22***a***1**, **22***a***2**, and **22***a***3**, using setting information, according to degrees to which doors **22** are opened. Note that for example, setter **39** obtains a mean value and variance of latest N measurement results (data items) (N is a natural number), and adopts the mean value as a valid distance only when the variance is a predetermined value or less.

[Other Variations]

[0120] In the above embodiments, refrigerator **20** may be a refrigerator for a typical household or may be a refrigerator for product display that is used in a shop such as a convenience store or may be a refrigerator for other business use.

[0121] In addition, if food items of a single type are stored in refrigerator **20**, the type of the food items may not be determined.

[0122] Refrigerator **20** is an example of a repository, and the present disclosure can be implemented as other repositories that do not have a cooling function. In addition, items (in other words, objects) stored in a repository are not limited to food, and may be other items. The case where items other than food are stored in refrigerator **20** can also be conceived.

ADVANTAGEOUS EFFECTS

[0123] As described above, storage-retrieval management device **30** includes: image capturer **31** that captures images each including markers as subjects from above refrigerator **20** that includes a first storage structure and a second storage structure, the images showing a scene in which an object is put into or taken out of refrigerator **20**, the markers being provided on the first storage structure and the second storage structure, the second storage structure being at a position different from a position of the first storage structure in a vertical direction; and determiner **37** that determines a storage position at which the object is stored, based on whether the markers included in the images are visible or hidden. Each of the first storage structure and the second storage structure is any of a shelf, a drawer, or a door compartment, for example. Specifically, the markers include first markers **27***a*, second markers **27***b*, third markers **27***c*, and fourth markers **27***d*, for instance. Refrigerator **20** is an example of a repository.

[0124] Such storage-retrieval management device **30** can manage storage positions of objects in refrigerator **20**.

[0125] For example, the first storage structure and the second storage structure are shelves (for example, shelf **24***a*

and shelf **24***b*) provided in a same storage space (for example, first storage space **23**). Determiner **37** determines in which one of shelf **24***a* or shelf **24***b* the storage position of the object is, based on whether the markers in the images are visible or hidden.

[0126] Such storage-retrieval management device **30** can manage whether a storage position of an object in refrigerator **20** is on shelf **24***a* or shelf **24***b*.

[0127] For example, the first storage structure defines first storage space **23**, the second storage structure defines second storage space **26** at a position different from a position of first storage space **23** in the vertical direction. Determiner **37** determines in which one of first storage space **23** or second storage space **26** the storage position of the object is, based on whether the markers in the images are visible or hidden.

[0128] Such storage-retrieval management device **30** can manage whether a storage position of an object in refrigerator **20** is in first storage space **23** or second storage space **26**.

[0129] For example, the first storage structure and the second storage structure are door compartments **22***a* provided in door **22** included in refrigerator **20**.

[0130] Such storage-retrieval management device **30** can manage whether a storage position of an object in refrigerator **20** is in first storage space **23** or second storage space **26**.

[0131] For example, the position of the first storage structure is above the position of the second storage structure. Determiner **37** determines that the storage position of the object corresponds to the position of the first storage structure when, out of the markers, a marker provided on the first storage structure is hidden in at least one of the images. Determiner **37** determines that the storage position of the object corresponds to the position of the second storage structure when the marker provided on the first storage structure is not hidden and, out of the markers, a marker provided on the second storage structure is hidden in at least one of the images.

[0132] Such storage-retrieval management device **30** can manage storage positions of objects in refrigerator **20**.

[0133] The first storage structure is provided with at least two markers out of the markers, and the second storage structure is provided with at least two markers out of the markers.

[0134] Such storage-retrieval management device **30** can manage in more detail a storage position of an object, based on which of the markers is hidden.

[0135] For example, determiner **37** further determines a type of the object. Storage-retrieval management device **30** further includes: informer **36** that gives notice when the type of the object is indeterminable.

[0136] With such notice from storage-retrieval management device **30**, the user can cope with the case by manually correcting the food management information.

[0137] For example, image capturer **31** includes a structure with which image capturer **31** is retrofittable onto refrigerator **20**.

[0138] Such image capturer **31** can be retrofitted onto refrigerator **20**.

[0139] Storage-retrieval management system **10** includes: storage-retrieval management device **30**; and server device **40**. Server device **40** includes: communicator **41** that receives, from storage-retrieval management device **30**, storage-retrieval information indicating that the object is stored into or retrieved from refrigerator **20**; and notifier **45** that notifies information terminal device **50** possessed by a user of refrigerator **20** when the storage-retrieval information is received during a period in which the user is not adjacent to refrigerator **20**.

[0140] With the notice from such storage-retrieval management system **10**, the user can be aware that food is put into or taken out of refrigerator **20** during a period in which the user is not adjacent to refrigerator **20**.

[0141] Storage-retrieval management system **10** includes: image capturer **31** that captures images each including markers as subjects from above refrigerator **20** that includes a first storage structure and a second storage structure, the images showing a scene in which an object is put into or taken out of refrigerator **20**, the markers being provided on the first storage structure and the second storage structure, the second storage structure being at a position different from a position of the first storage structure in a vertical direction; and determiner **37** that determines a storage position at which the object is stored, based on whether the markers included in the images are visible or hidden. As with storage-retrieval management system **10***a*, determiner **37** may be included in server device **40***a*.

[0142] Such storage-retrieval management system **10** can manage storage positions of objects in refrigerator **20**.

[0143] A storage-retrieval management method executed by a computer such as storage-retrieval management system **10** includes: capturing images each including markers as subjects from above refrigerator **20** that includes a first storage structure and a second storage structure, the images showing a scene in which an object is put into or taken out of refrigerator **20**, the markers being provided on the first storage structure and the second storage structure, the second storage structure being at a position different from a position of the first storage structure in a vertical direction; and determining a storage position at which the object is stored, based on whether the markers included in the images are visible or hidden.

[0144] With such a storage-retrieval management method, storage positions of objects in refrigerator **20** can be managed.

Other Embodiments

[0145] Although the above has described embodiments, the present disclosure is not limited to the above embodiments.

[0146] For example, the above embodiments have described that a marker is a two-dimensional code, yet the marker does not need to be a two-dimensional code, but may be a graphic or a line that extends in the width direction of a refrigerator. Further, a pattern for another use (for example, a pattern made by a groove provided in a shelf) provided in the refrigerator may be used as a marker. A specific aspect of a marker is not limited in particular.

[0147] A method for providing a storage structure with a marker is not limited in particular. For example, a marker may be provided onto a storage structure by sticking onto the storage structure a sticker on which the marker is printed. Accordingly, the storage-retrieval management system can manage objects stored in a repository (refrigerator) onto which a marker is not originally provided.

[0148] In the embodiments above, the storage-retrieval management system is implemented by a plurality of devices, but may be implemented by a single device. For

example, the storage-retrieval management system may be implemented as a single device corresponding to the storage-retrieval management device according to the above embodiment, or may be implemented by a single device corresponding to a server device. When the storage-retrieval management system is implemented by a plurality of devices, how elements included in the storage-retrieval management system are distributed among the plurality of devices is not specifically determined.

[0149] For example, a method for communication between devices in the above embodiments is not limited in particular. In the communication between devices, a relay device not illustrated may be provided between the devices. A path for information transmission described in the above embodiment is not limited to the transmission paths illustrated in the sequence diagrams.

[0150] For example, in the above embodiment, processing executed by a particular processor may be executed by another processor. The order of processes may be changed or plural processes may be executed in parallel.

[0151] In the above embodiments, each of the elements may be implemented by executing a software program suitable for the element. Each element may be implemented by a program executor such as a CPU or a processor reading and executing a software program recorded on a recording medium such as a hard disk or semiconductor memory.

[0152] Further, each element may be implemented by hardware. For example, each element may be a circuit (or an integrated circuit). The circuits may constitute one circuit as a whole or may be separate circuits. These circuits may be general-purpose circuits or dedicated circuits.

[0153] General and specific aspects of the present disclosure may be implemented using a system, a device, a method, an integrated circuit, a computer program, or a computer-readable recording medium such as a CD-ROM. The general and specific aspects of the present disclosure may be implemented using any combination of systems, devices, methods, integrated circuits, computer programs, and recording media.

[0154] For example, the present disclosure may be implemented as an object storage-retrieval management method executed by a computer, or may be implemented as a program for causing a computer to execute the storage-retrieval management method. The present disclosure may be implemented as a non-transitory computer-readable recording medium having such a program recorded thereon.

[0155] The present disclosure also encompasses embodiments resulting from applying various modifications, which may be conceived by those skilled in the art, to the embodiments, and other embodiments resulting from combining elements and functions in the embodiments, without departing from the gist of the present disclosure.

REFERENCE SIGNS LIST

[0156] **10**, **10***a* storage-retrieval management system
[0157] **20** refrigerator (repository)
[0158] **21** main body
[0159] **22** door
[0160] **22***a* door compartment
[0161] **23** first storage space
[0162] **24** shelf
[0163] **24***a* upper shelf
[0164] **24***b* lower shelf
[0165] **26** second storage space
[0166] **27***a* first marker
[0167] **27***b* second marker
[0168] **27***c* third marker
[0169] **27***d* fourth marker
[0170] **30**, **30***a* storage-retrieval management device
[0171] **31** image capturer
[0172] **32** distance measurer
[0173] **33**, **42** information processor
[0174] **34**, **43** memory
[0175] **35**, **41** communicator
[0176] **36** informer
[0177] **37**, **46** determiner
[0178] **38**, **47** tracker
[0179] **39** setter
[0180] **40**, **40***a* server device (notification device)
[0181] **44** presenter
[0182] **45** notifier
[0183] **50** information terminal device
[0184] **60** wide-area communication network

1. A storage-retrieval management device comprising:
an image capturer that captures images each including markers as subjects from above a repository that includes a first storage structure and a second storage structure, the images showing a scene in which an object is put into or taken out of the repository, the markers being provided on the first storage structure and the second storage structure, the second storage structure being at a position different from a position of the first storage structure in a vertical direction; and
a determiner that determines a storage position at which the object is stored, based on whether the markers included in the images are visible or hidden,
wherein the first storage structure and the second storage structure are door compartments provided in a door included in the repository, and
the markers include region markers in the images, the region markers being set by dividing, into predetermined regions, a bottom surface of at least one of the door compartments that are the first storage structure and the second storage structure.

2. The storage-retrieval management device according to claim **1**,
wherein
the determiner determines on which of the region markers structure the storage position of the object is, based on whether the region markers in the images are visible or hidden in the at least one of the door compartments in which the region markers are set.

3. The storage-retrieval management device according to claim **1**,
wherein the first storage structure defines a first storage space,
the second storage structure defines a second storage space at a position different from a position of the first storage space in the vertical direction, and
the determiner determines in which one of the first storage space or the second storage space the storage position of the object is, based on whether the markers in the images are visible or hidden.

4. (canceled)

5. The storage-retrieval management device according to claim **1**,
wherein the position of the first storage structure is above the position of the second storage structure,

the determiner determines that the storage position of the object corresponds to the position of the first storage structure when, out of the markers, a marker provided on the first storage structure is hidden in at least one of the images, and

the determiner determines that the storage position of the object corresponds to the position of the second storage structure when the marker provided on the first storage structure is not hidden and, out of the markers, a marker provided on the second storage structure is hidden in at least one of the images.

6. (canceled)

7. The storage-retrieval management device according to claim **1**,

wherein the determiner further determines a type of the object, and

the storage-retrieval management device further comprises:

an informer that gives notice when the type of the object is indeterminable.

8. (canceled)

9. (canceled)

10. A storage-retrieval management system comprising:

the storage-retrieval management device according to claim **1**; and

a notification device,

wherein the notification device includes:

a communicator that receives, from the storage-retrieval management device,

information indicating that the object is stored into or retrieved from the repository; and

a notifier that notifies an information terminal device possessed by a user of the repository when the information is received during a period in which the user is not adjacent to the repository.

11. A storage-retrieval management system comprising:

an image capturer that captures images each including markers as subjects from above a repository that includes a first storage structure and a second storage structure, the images showing a scene in which an object is put into or taken out of the repository, the markers being provided on the first storage structure and the second storage structure, the second storage structure being at a position different from a position of the first storage structure in a vertical direction; and

a determiner that determines a storage position at which the object is stored, based on whether the markers included in the images are visible or hidden,

wherein the first storage structure and the second storage structure are door compartments provided in a door included in the repository, and

the markers include region markers in the images, the region markers being set by dividing, into predetermined regions, a bottom surface of at least one of the door compartments that are the first storage structure and the second storage structure.

12. A storage-retrieval management method comprising:

capturing images each including markers as subjects from above a repository that includes a first storage structure and a second storage structure, the images showing a scene in which an object is put into or taken out of the repository, the markers being provided on the first storage structure and the second storage structure, the second storage structure being at a position different from a position of the first storage structure in a vertical direction; and

determining a storage position at which the object is stored, based on whether the markers included in the images are visible or hidden,

wherein the first storage structure and the second storage structure are door compartments provided in a door included in the repository, and

the markers include region markers in the images, the region markers being set by dividing, into predetermined regions, a bottom surface of at least one of the door compartments that are the first storage structure and the second storage structure.

13. A non-transitory computer-readable recording medium having recorded thereon a program for causing a computer to execute the storage-retrieval management method according to claim **12**.

14. The storage-retrieval management device according to claim **1**,

wherein the region markers are changeable according to an opening angle of the door, and

the determiner determines the storage position of the object with use of the region markers set according to the opening angle of the door.

15. The storage-retrieval management device according to claim **14**, further comprising:

a distance measurer that measures a distance from the distance measurer to the door,

wherein the opening angle of the door is determined with use of the distance measured by the distance measurer, and

the determiner determines the storage position of the object with use of the region markers set according to the opening angle of the door that is determined.

16. The storage-retrieval management device according to claim **15**, further comprising:

a setter that sets the region markers,

wherein the setter determines a distance for use in determining the opening angle of the door, by using results of the distance measurer measuring the distance from the distance measurer to the door a predetermined number of times.

17. The storage-retrieval management device according to claim **14**, further comprising:

a sensor that measures the opening angle of the door,

wherein the determiner determines the storage position of the object with use of the region markers set according to the opening angle of the door measured by the sensor.

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