US012388946B2

(12) **United States Patent**
Horiuchi et al.

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(45) **Date of Patent: Aug. 12, 2025**

(54) **DISPLAY TERMINAL, COMMUNICATION SYSTEM, AND DISPLAY METHOD**

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(73) Assignee: **RICOH COMPANY, LTD.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **18/522,269**

(22) Filed: **Nov. 29, 2023**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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Sep. 21, 2023 (JP) 2023-156333

(51) **Int. Cl.**
H04N 5/262 (2006.01)
H04N 7/18 (2006.01)

(52) **U.S. Cl.**
CPC ***H04N 5/2628*** (2013.01); ***H04N 7/181*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

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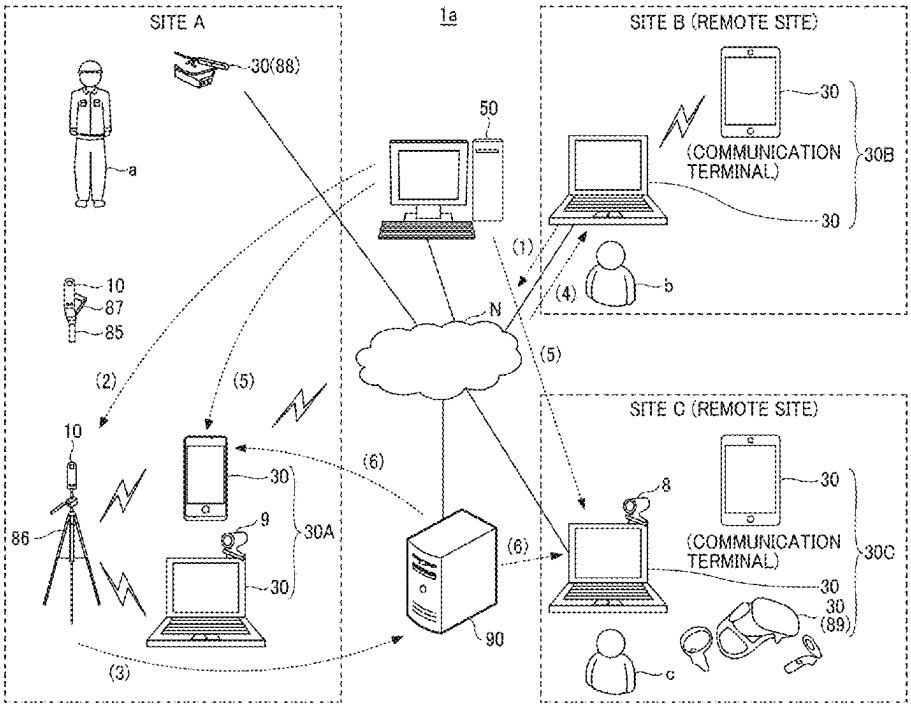
Primary Examiner — Daniel T Tekle
(74) *Attorney, Agent, or Firm* — XSENSUS LLP

(57) **ABSTRACT**

A display terminal comprising circuitry that displays a first predetermined-area image on a display screen, the first predetermined-area image representing a predetermined area in a first wide-view image having been captured at a given location on a first date and time; and displays a second predetermined-area image on the display screen, the second predetermined-area image being related to the predetermined area in a second wide-view image, the second wide-view image having captured at the given location on a second date and time different from the first date and time.

8 Claims, 39 Drawing Sheets



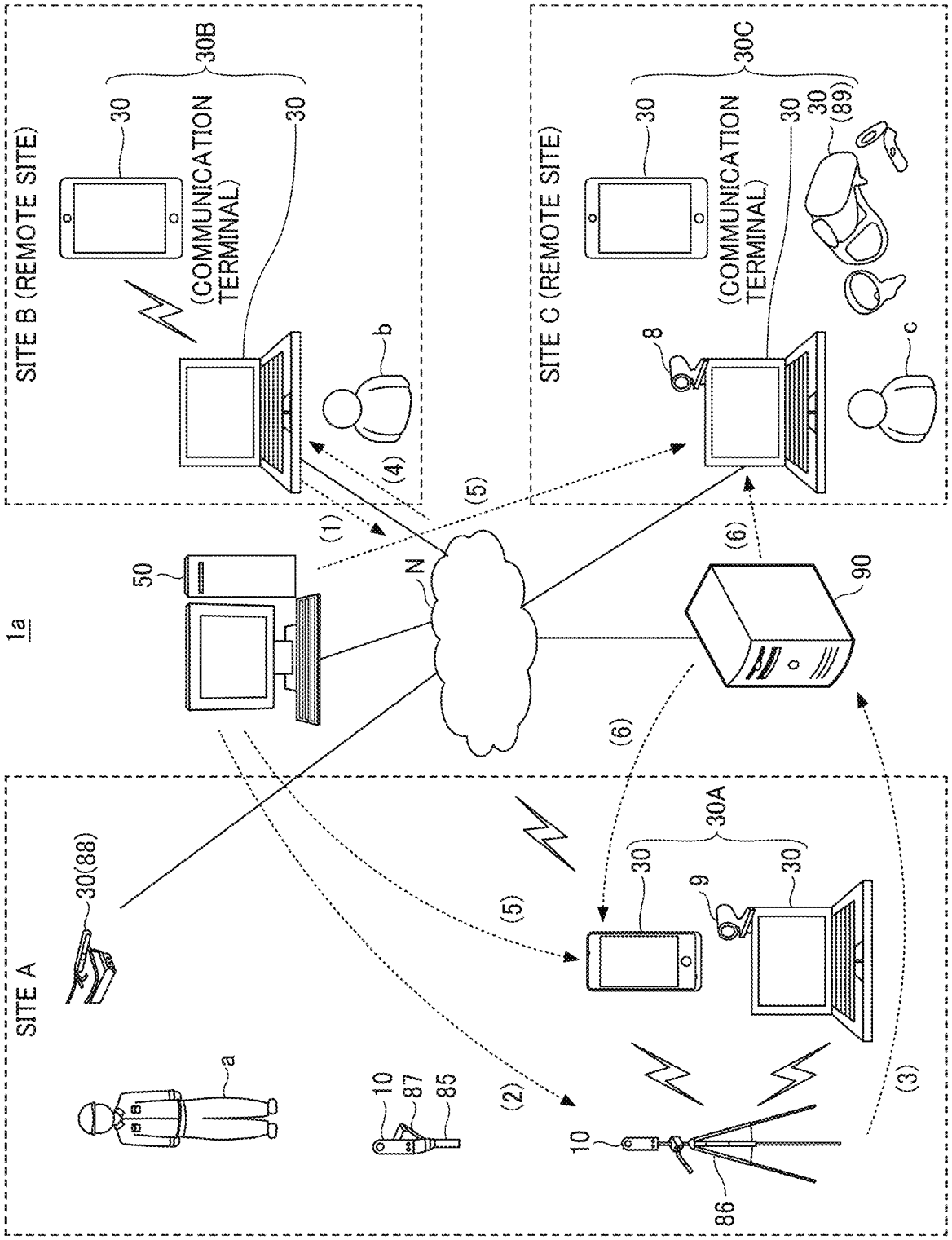

SITE A
SITE B (REMOTE SITE)
SITE C (REMOTE SITE)
1a
N
50
90
30B
30C
30A
30
30(88)
30(89)
(COMMUNICATION TERMINAL)
a
b
c
8
9
10
85
86
87
(1)
(2)
(3)
(4)
(5)
(6)

FIG. 1

FIG. 2

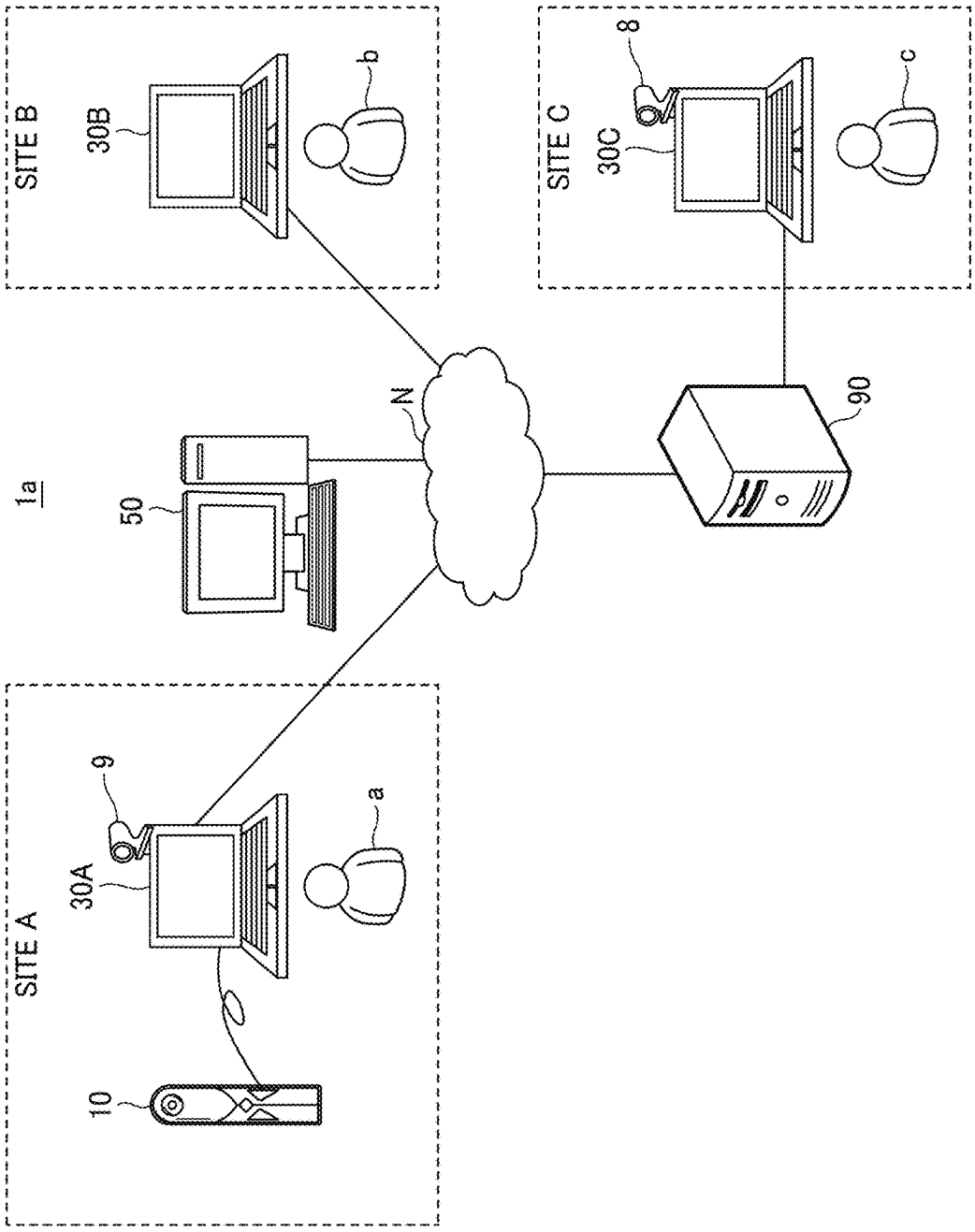


FIG. 3

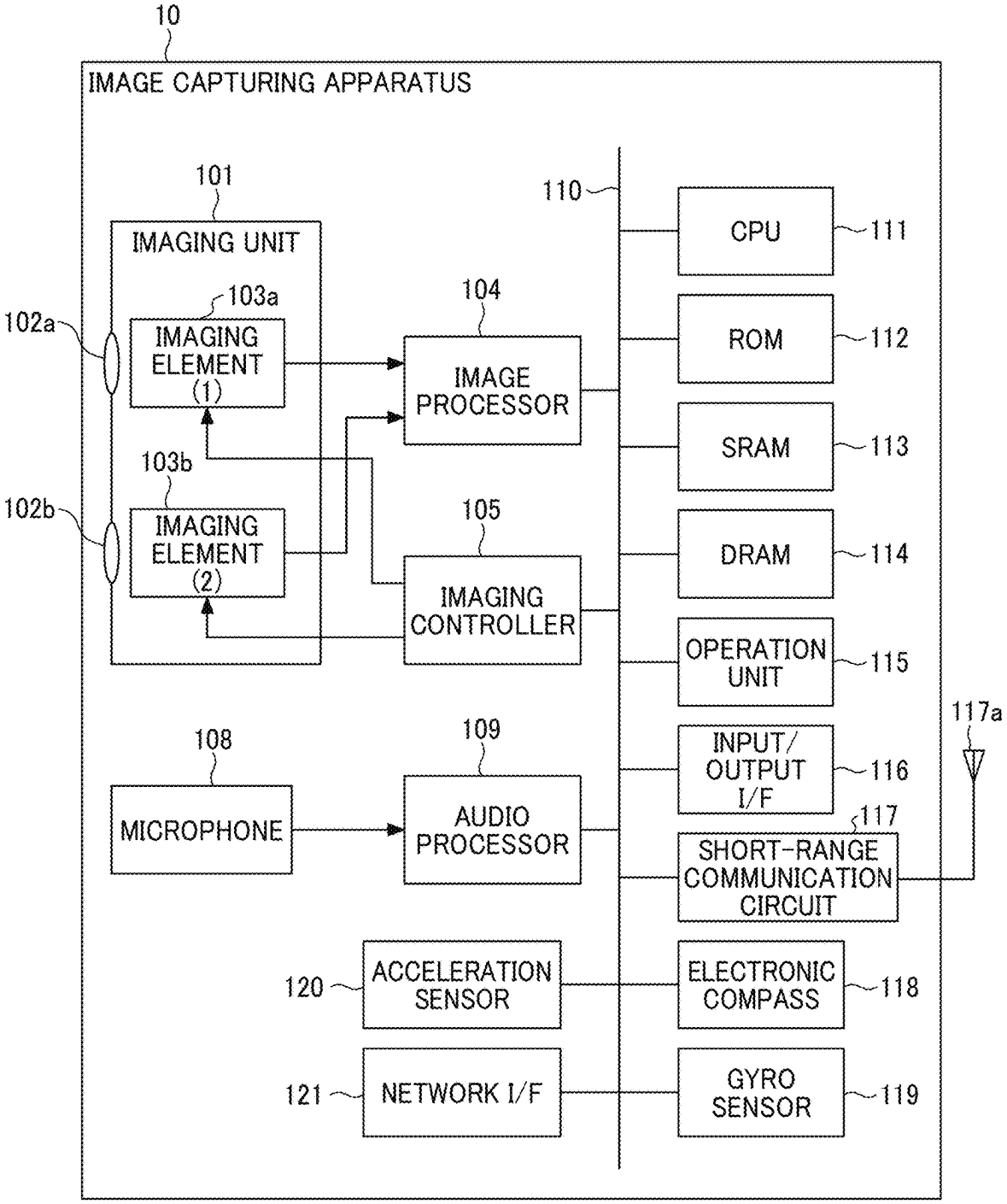

10
IMAGE CAPTURING APPARATUS
101
IMAGING UNIT
103a
IMAGING ELEMENT (1)
102a
103b
IMAGING ELEMENT (2)
102b
104
IMAGE PROCESSOR
105
IMAGING CONTROLLER
108
MICROPHONE
109
AUDIO PROCESSOR
110
CPU
111
ROM
112
SRAM
113
DRAM
114
OPERATION UNIT
115
INPUT/ OUTPUT I/F
116
117
SHORT-RANGE COMMUNICATION CIRCUIT
117a
ELECTRONIC COMPASS
118
GYRO SENSOR
119
120
ACCELERATION SENSOR
121
NETWORK I/F

FIG. 4

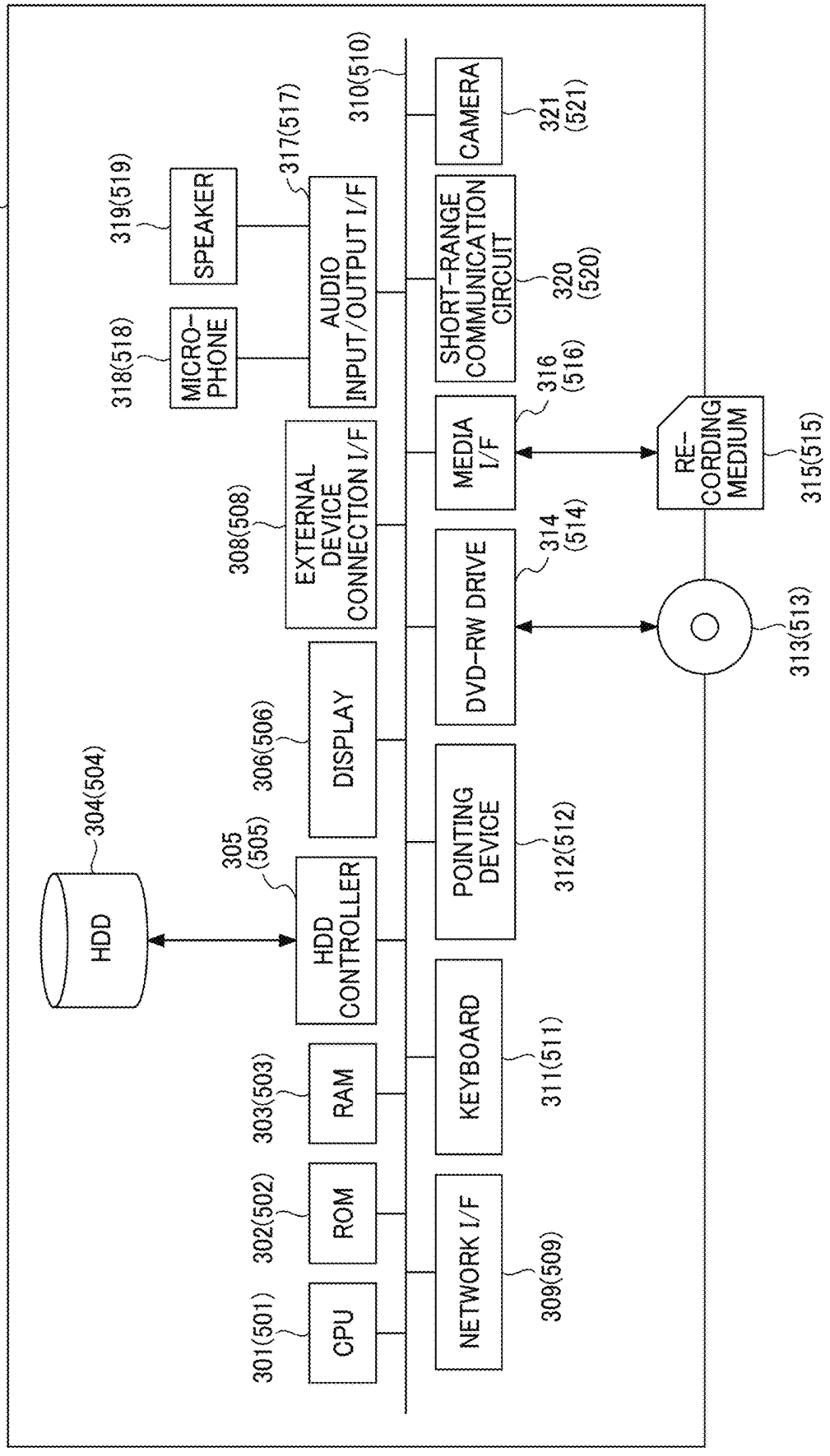

30, 50
CPU
301(501)
ROM
302(502)
RAM
303(503)
HDD CONTROLLER
305 (505)
HDD
304(504)
DISPLAY
306(506)
EXTERNAL DEVICE CONNECTION I/F
308(508)
NETWORK I/F
309(509)
KEYBOARD
311(511)
POINTING DEVICE
312(512)
DVD-RW DRIVE
314 (514)
313(513)
MEDIA I/F
316 (516)
RE-CORDING MEDIUM
315(515)
AUDIO INPUT/OUTPUT I/F
317(517)
MICRO-PHONE
318(518)
SPEAKER
319(519)
SHORT-RANGE COMMUNICATION CIRCUIT
320 (520)
CAMERA
321 (521)
310(510)

FIG. 5C

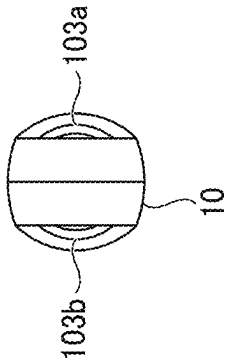


FIG. 5B

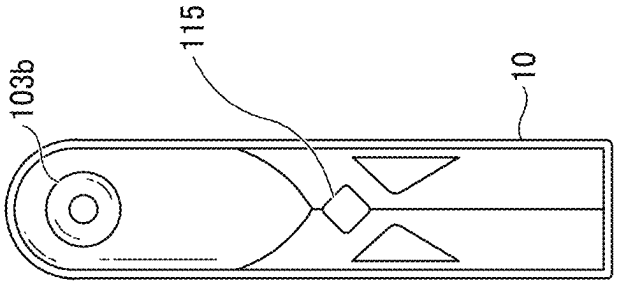


FIG. 5A

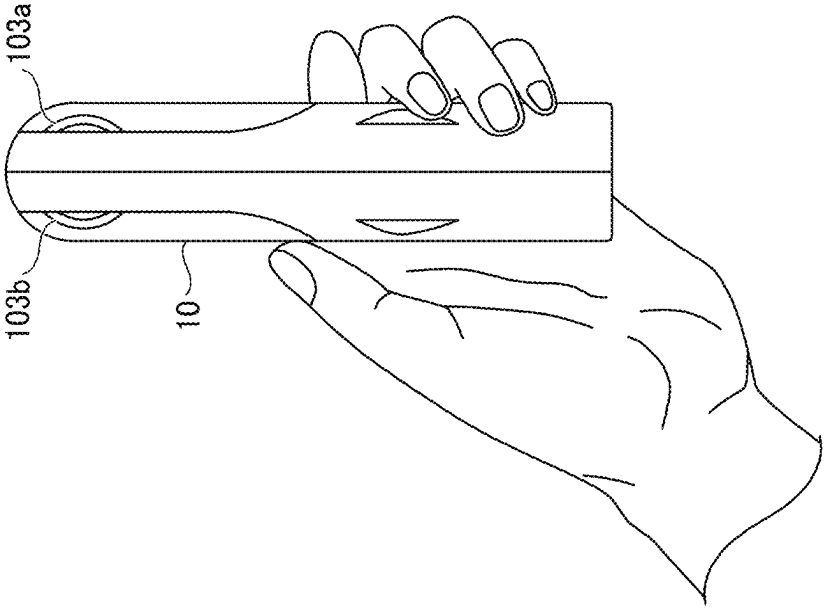


FIG. 6

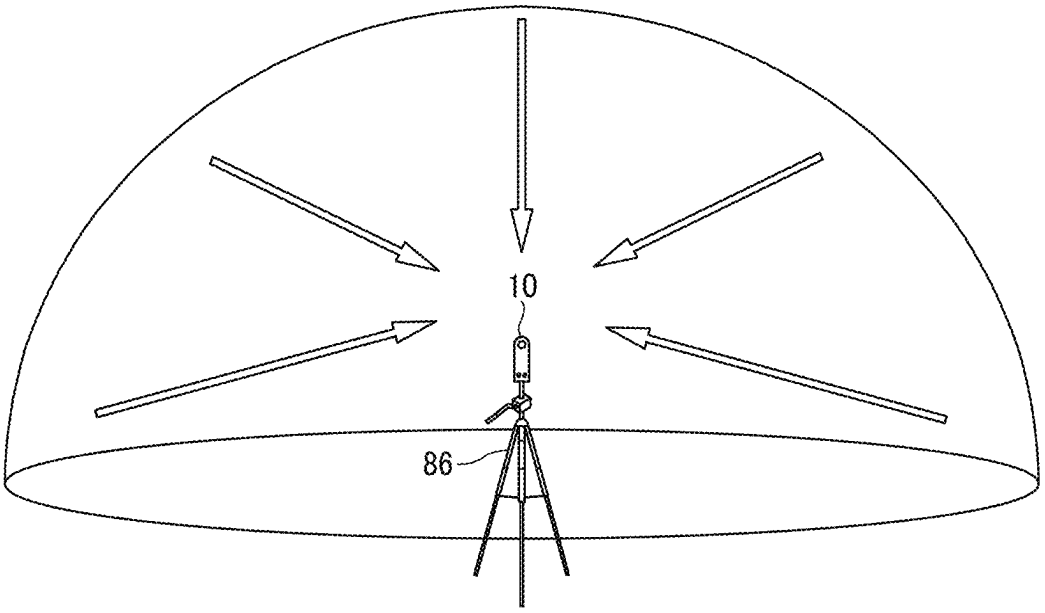


FIG. 7A

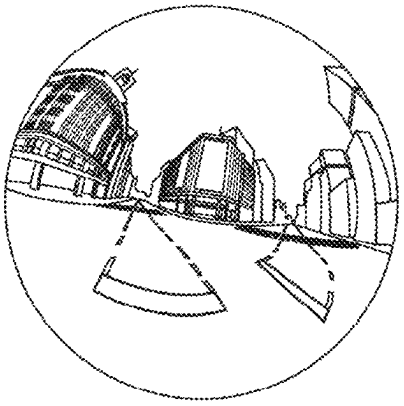


FIG. 7B

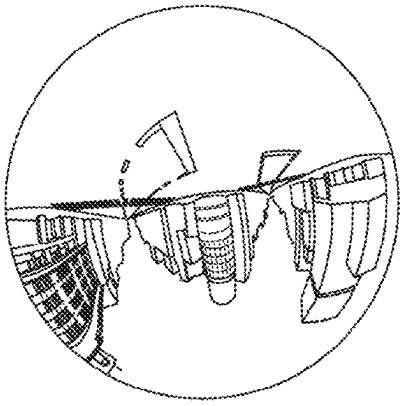


FIG. 7C

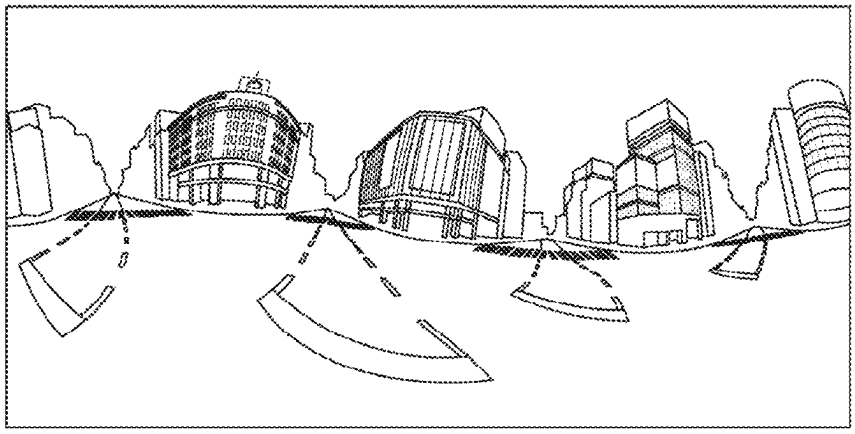
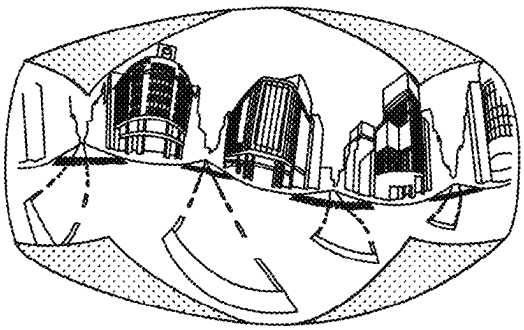


FIG. 8A



EQUIRECTANGULAR PROJECTION IMAGE EC

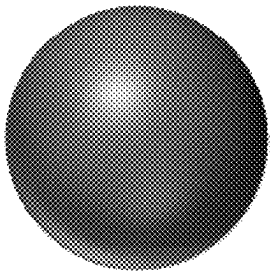
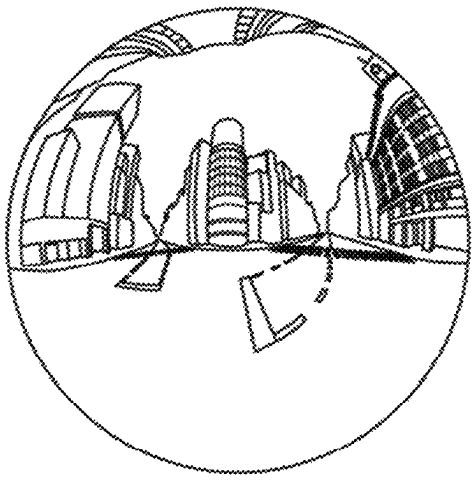


FIG. 8B



SPHERICAL IMAGE CE

FIG. 9

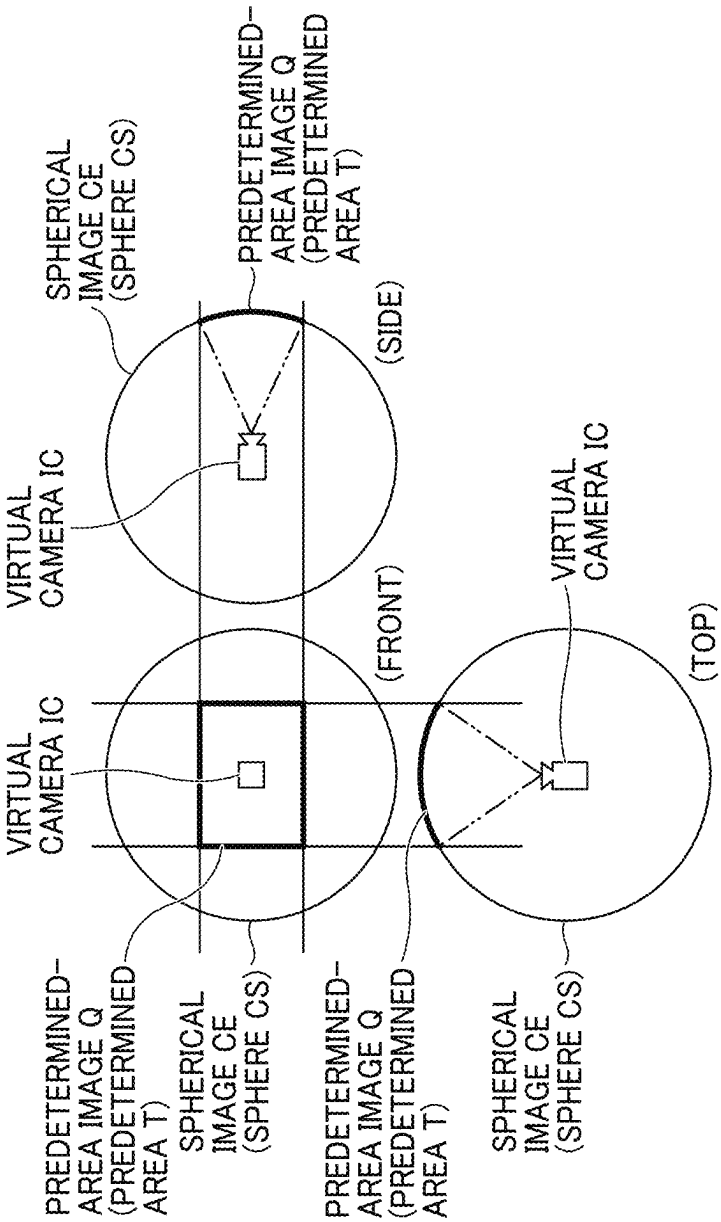

VIRTUAL CAMERA IC
SPHERICAL IMAGE CE (SPHERE CS)
PREDETERMINED-AREA IMAGE Q (PREDETERMINED AREA T)
(SIDE)
VIRTUAL CAMERA IC
(FRONT)
PREDETERMINED-AREA IMAGE Q (PREDETERMINED AREA T)
SPHERICAL IMAGE CE (SPHERE CS)
VIRTUAL CAMERA IC
(TOP)
PREDETERMINED-AREA IMAGE Q (PREDETERMINED AREA T)
SPHERICAL IMAGE CE (SPHERE CS)

FIG. 10A

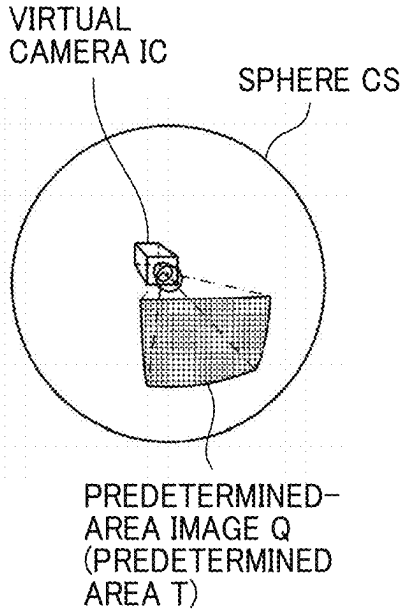


FIG. 10B

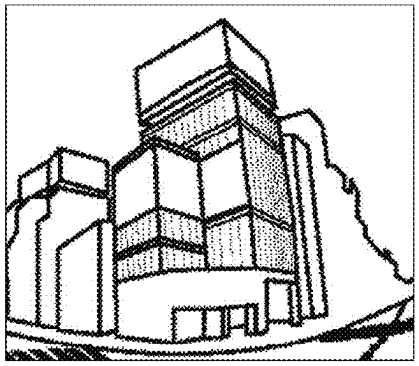


FIG. 10C

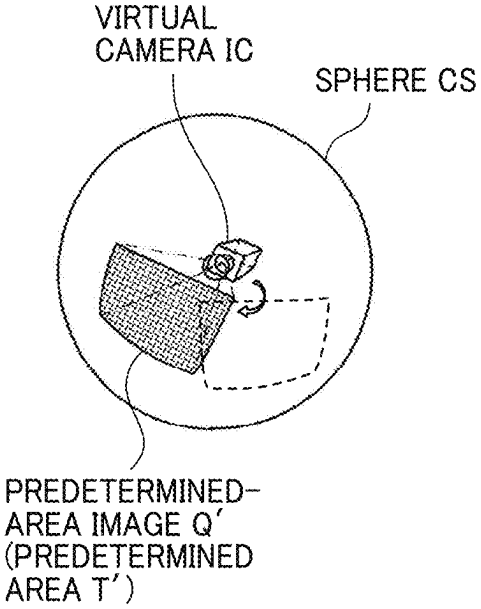


FIG. 10D

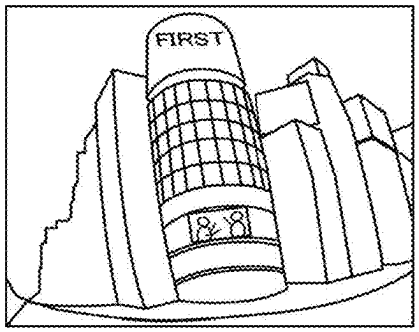


FIG. 11

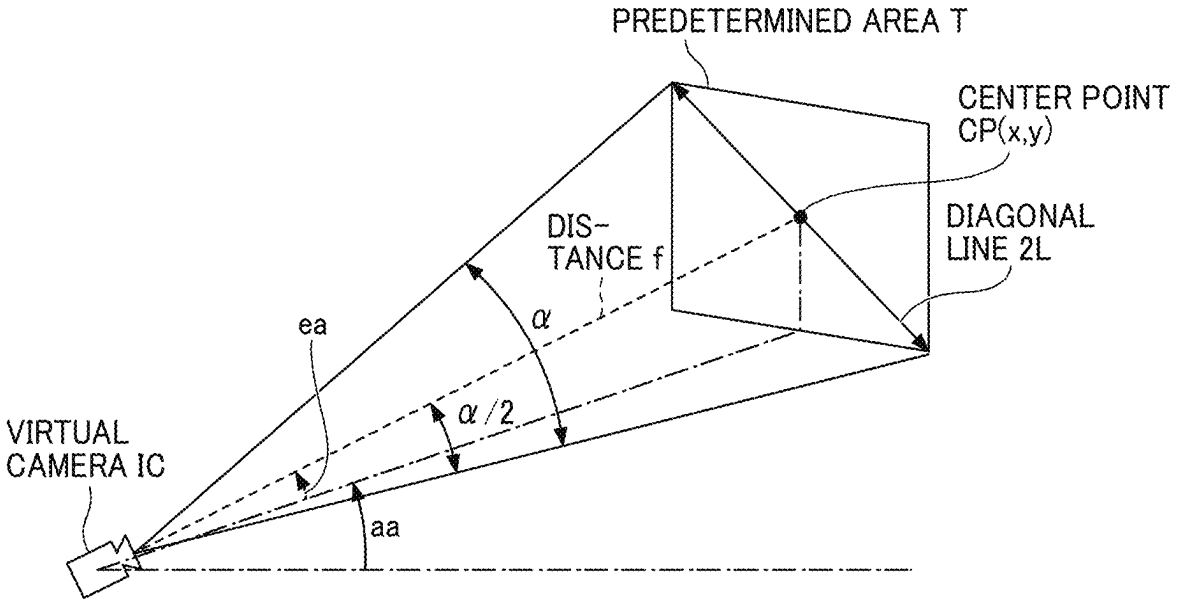

PREDETERMINED AREA T
CENTER POINT
CP(x,y)
DIAGONAL
LINE 2L
DIS-
TANCE f
α
ea
α/2
VIRTUAL
CAMERA IC
aa

FIG. 12

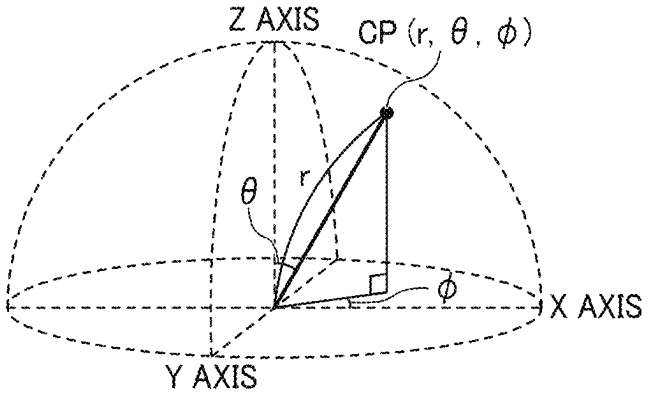

Z AXIS
CP (r, θ, ϕ)
θ
r
ϕ
X AXIS
Y AXIS

FIG. 13

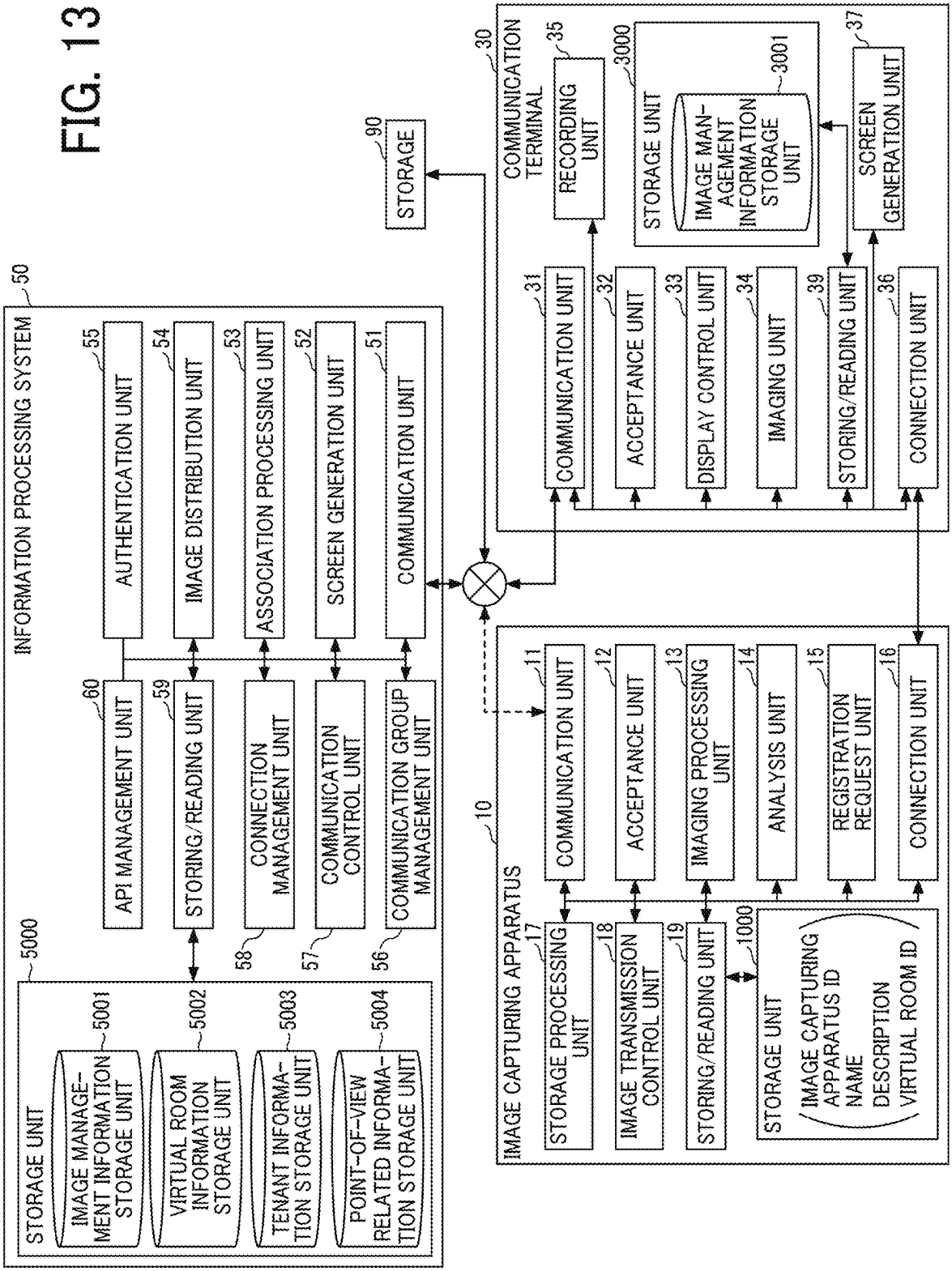

INFORMATION PROCESSING SYSTEM
50
STORAGE UNIT
5000
IMAGE MANAGEMENT INFORMATION STORAGE UNIT
5001
VIRTUAL ROOM INFORMATION STORAGE UNIT
5002
TENANT INFORMATION STORAGE UNIT
5003
POINT-OF-VIEW RELATED INFORMATION STORAGE UNIT
5004
API MANAGEMENT UNIT
60
STORING/READING UNIT
59
CONNECTION MANAGEMENT UNIT
58
COMMUNICATION CONTROL UNIT
57
COMMUNICATION GROUP MANAGEMENT UNIT
56
AUTHENTICATION UNIT
55
IMAGE DISTRIBUTION UNIT
54
ASSOCIATION PROCESSING UNIT
53
SCREEN GENERATION UNIT
52
COMMUNICATION UNIT
51
STORAGE
90
COMMUNICATION TERMINAL
30
COMMUNICATION UNIT
31
ACCEPTANCE UNIT
32
DISPLAY CONTROL UNIT
33
IMAGING UNIT
34
STORING/READING UNIT
39
CONNECTION UNIT
36
RECORDING UNIT
35
STORAGE UNIT
3000
IMAGE MANAGEMENT INFORMATION STORAGE UNIT
3001
SCREEN GENERATION UNIT
37
IMAGE CAPTURING APPARATUS
10
COMMUNICATION UNIT
11
ACCEPTANCE UNIT
12
IMAGING PROCESSING UNIT
13
ANALYSIS UNIT
14
REGISTRATION REQUEST UNIT
15
CONNECTION UNIT
16
STORAGE PROCESSING UNIT
17
IMAGE TRANSMISSION CONTROL UNIT
18
STORING/READING UNIT
19
STORAGE UNIT
1000
IMAGE CAPTURING APPARATUS ID
NAME
DESCRIPTION
VIRTUAL ROOM ID

FIG. 14A

DATA ID OF WIDE-VIEW IMAGE	DATA NAME	IMAGING START DATE AND TIME INFORMATION	IMAGING END DATE AND TIME INFORMATION	IMAGING OPERATOR INFORMATION	IMAGE CAPTURING APPARATUS INFORMATION	IMAGING-TIME VIRTUAL ROOM ID	DATA STORAGE LOCATION INFORMATION	PARTICIPANT ID
111	BUILDING X UNDER CONSTRUCTION	2021/10/12 9:00	2021/10/12 10:00	User110	T111	AAA	https://···	User121, User122
112	BUILDING X UNDER CONSTRUCTION	2021/10/12 10:00	2021/10/12 11:00	User110	T111	AAA	https://···	User121, User122
222	GROUP PHOTOGRAPH AT EVENT Y	2021/10/12 10:00	2021/10/12 10:00	User210	T222	BBB	https://···	User221, User222
333	SURGERY Z	2021/10/15 11:00	2021/10/15 11:00	User310	T333	CCC	https://···	User321, User322
444	···	···	···	···	···	···	···	···

FIG. 14B

DATA ID OF WIDE-VIEW IMAGE	DATA NAME	IMAGING START DATE AND TIME INFORMATION	IMAGING END DATE AND TIME INFORMATION	IMAGING OPERATOR INFORMATION	IMAGE CAPTURING APPARATUS INFORMATION	IMAGING-TIME VIRTUAL ROOM ID	DATA STORAGE LOCATION INFORMATION	PARTICIPANT ID
111	BUILDING X(1)	2021/10/12 9:00	2021/10/12 10:00	User110	T111	AAA	https://···	User121, User122
112	BUILDING X(1)	2021/10/12 10:00	2021/10/12 11:00	User110	T111	AAA	https://···	User121, User122
222	BUILDING X(2)	2021/10/12 10:00	2021/10/12 10:00	User210	T222	BBB	https://···	User221, User222
333	SURGERY Z	2021/10/15 11:00	2021/10/15 11:00	User310	T333	CCC	https://···	User321, User322
444	···	···	···	···	···	···	···	···

FIG. 15A

VIRTUAL ROOM INFORMATION

ITEM NAME	DEFINITION	EXAMPLE OF VALUE
VIRTUAL ROOM ID	IDENTIFICATION INFORMATION FOR IDENTIFYING VIRTUAL ROOM	AAA
VIRTUAL ROOM NAME	NAME FOR USER TO IDENTIFY VIRTUAL ROOM	CONSTRUCTION SITE A
DEVICE INFORMATION	IDENTIFICATION INFORMATION OF DEVICE ASSOCIATED WITH VIRTUAL ROOM	T111
USER IN VIRTUAL ROOM	USER WHO IS CURRENTLY IN VIRTUAL ROOM AND AUTHORIZED TO VIEW WIDE-VIEW IMAGE	User111 (IP ADDRESS OF COMMUNICATION TERMINAL) User222 (IP ADDRESS OF COMMUNICATION TERMINAL) User333 (IP ADDRESS OF COMMUNICATION TERMINAL)
STORAGE	INFORMATION ON STORAGE ASSOCIATED WITH VIRTUAL ROOM	ADDRESS INFORMATION OF STORAGE X INFORMATION ON FOLDER IN STORAGE X

FIG. 15B

TENANT INFORMATION

ITEM NAME	DEFINITION	EXAMPLE OF VALUE
TENANT ID	IDENTIFICATION INFORMATION FOR IDENTIFYING TENANT	T001
TENANT NAME	NAME FOR USER TO IDENTIFY TENANT	COMPANY X
TENANT-REGISTERED VIRTUAL ROOM ID	IDENTIFICATION INFORMATION OF VIRTUAL ROOM REGISTERED IN TENANT	R001 (CONSTRUCTION SITE A) R002 (CONSTRUCTION SITE B) R003 (CONSTRUCTION SITE C)
TENANT-REGISTERED DEVICE	DEVICE REGISTERED IN TENANT	- IMAGE CAPTURING APPARATUS ID NAME, DESCRIPTION, VIRTUAL ROOM ID - VR GOGGLES ID ..... - SMART GLASSES ID .....

FIG. 16

DATA ID OF WIDE-VIEW IMAGE	PARTICIPANT ID	VIEWING START DATE AND TIME INFORMATION	STORAGE LOCATION INFORMATION OF POINT-OF-VIEW INFORMATION
111	User120	2021/10/12 9:00	https://...
111	User121	2021/10/12 9:05	https://...
111	User122	2021/10/15 9:10	https://...
...	...	...	...

FIG. 17A

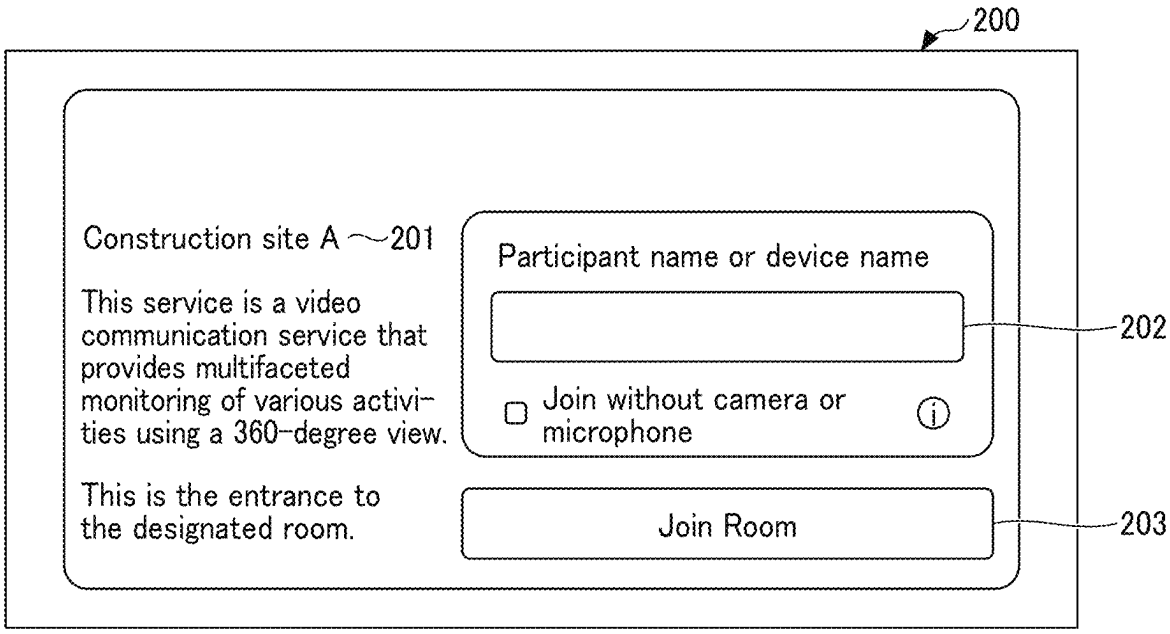


FIG. 17B

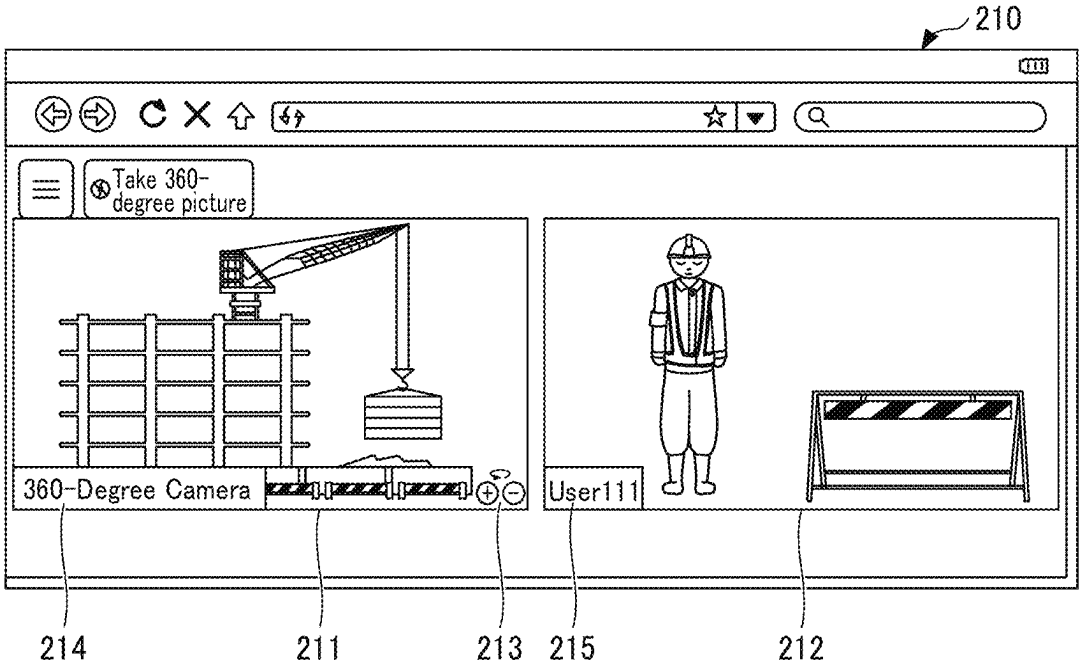


FIG. 18

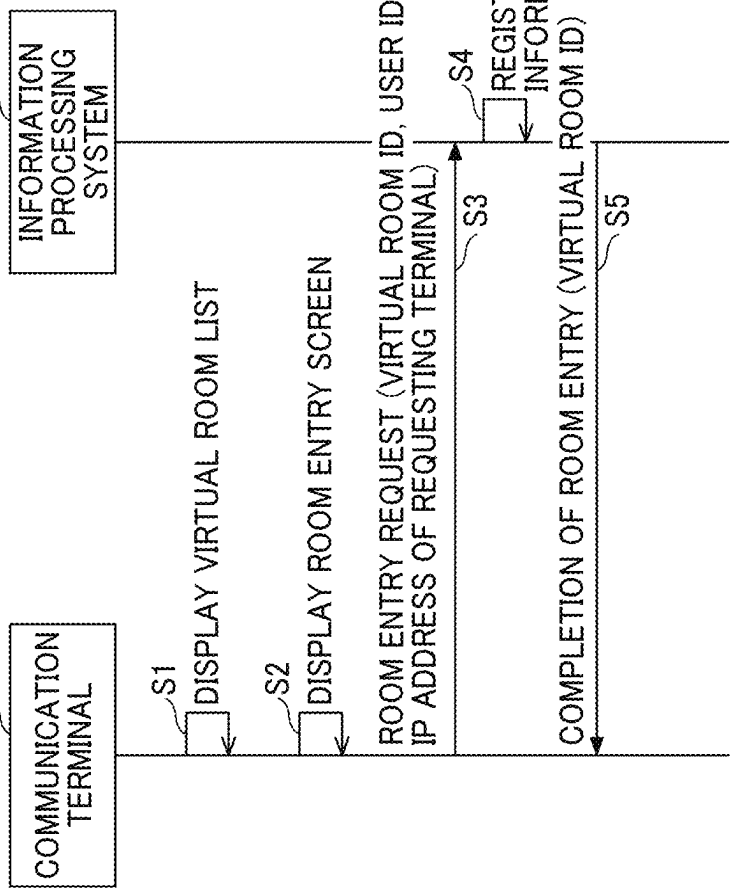

30B
COMMUNICATION TERMINAL
50
INFORMATION PROCESSING SYSTEM
S1
DISPLAY VIRTUAL ROOM LIST
S2
DISPLAY ROOM ENTRY SCREEN
ROOM ENTRY REQUEST (VIRTUAL ROOM ID, USER ID, IP ADDRESS OF REQUESTING TERMINAL)
S3
S4
REGISTER IN VIRTUAL ROOM INFORMATION STORAGE UNIT
COMPLETION OF ROOM ENTRY (VIRTUAL ROOM ID)
S5

FIG. 19

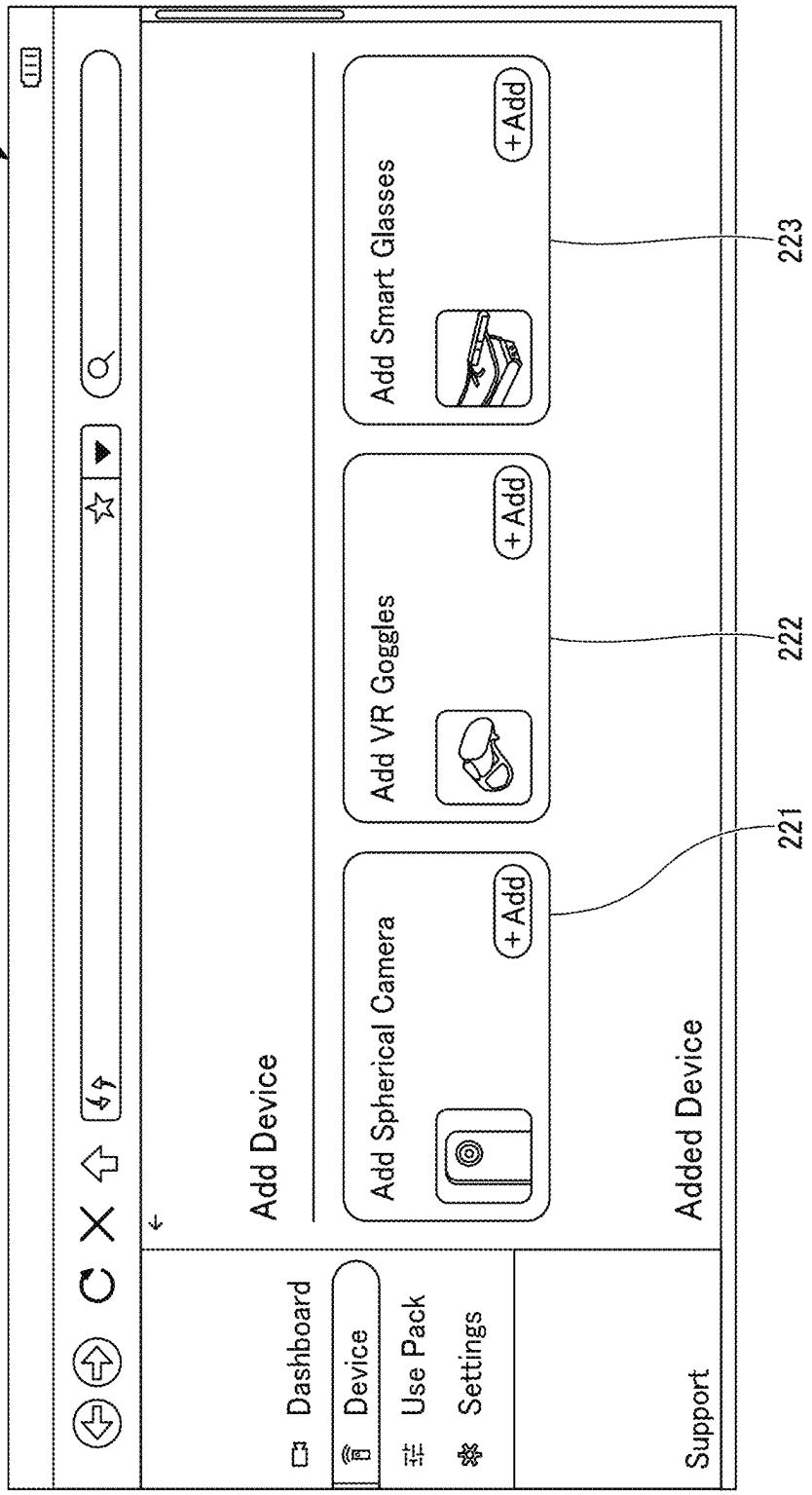

220
Dashboard
Device
Use Pack
Settings
Support
Add Device
Add Spherical Camera
+ Add
Add VR Goggles
+ Add
Add Smart Glasses
+ Add
Added Device
221
222
223

FIG. 20B

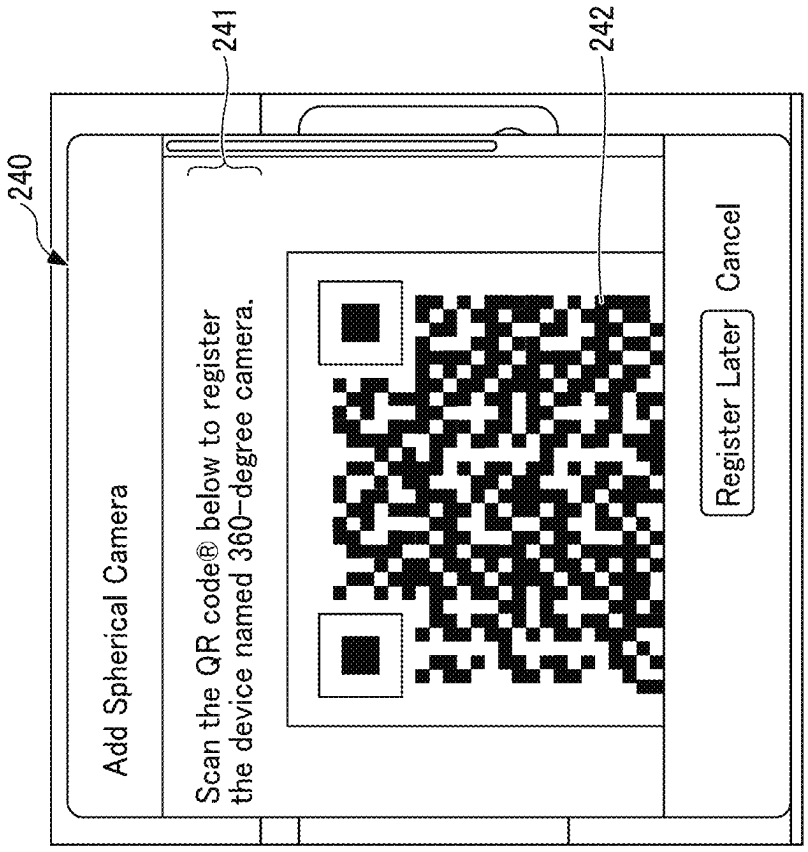


FIG. 20A

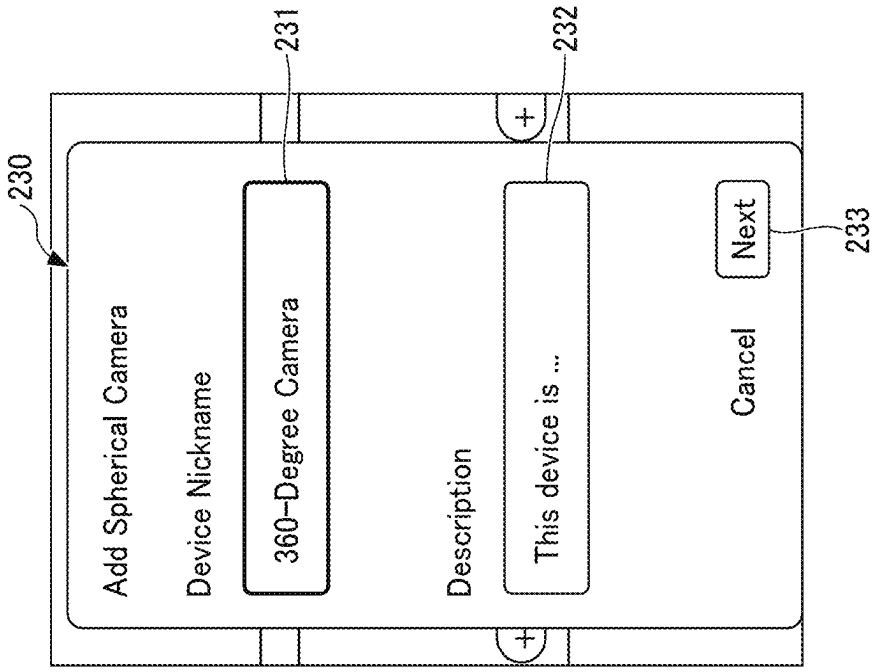


FIG. 21

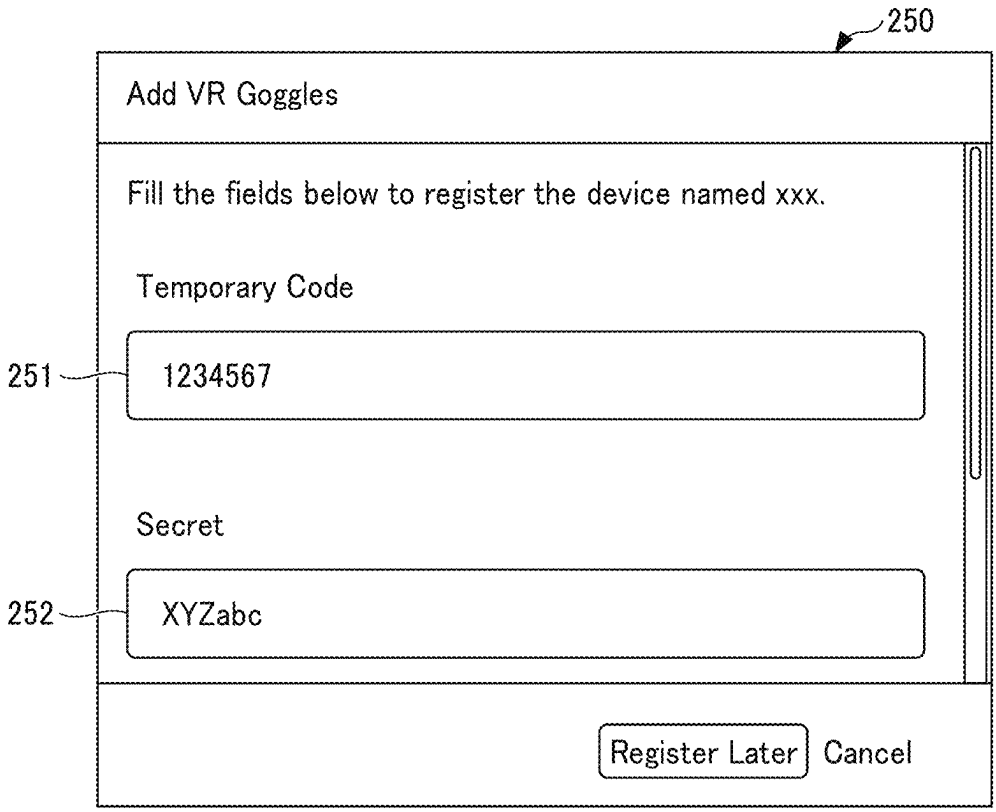

250
Add VR Goggles
Fill the fields below to register the device named xxx.
Temporary Code
251
1234567
Secret
252
XYZabc
Register Later
Cancel

FIG. 22

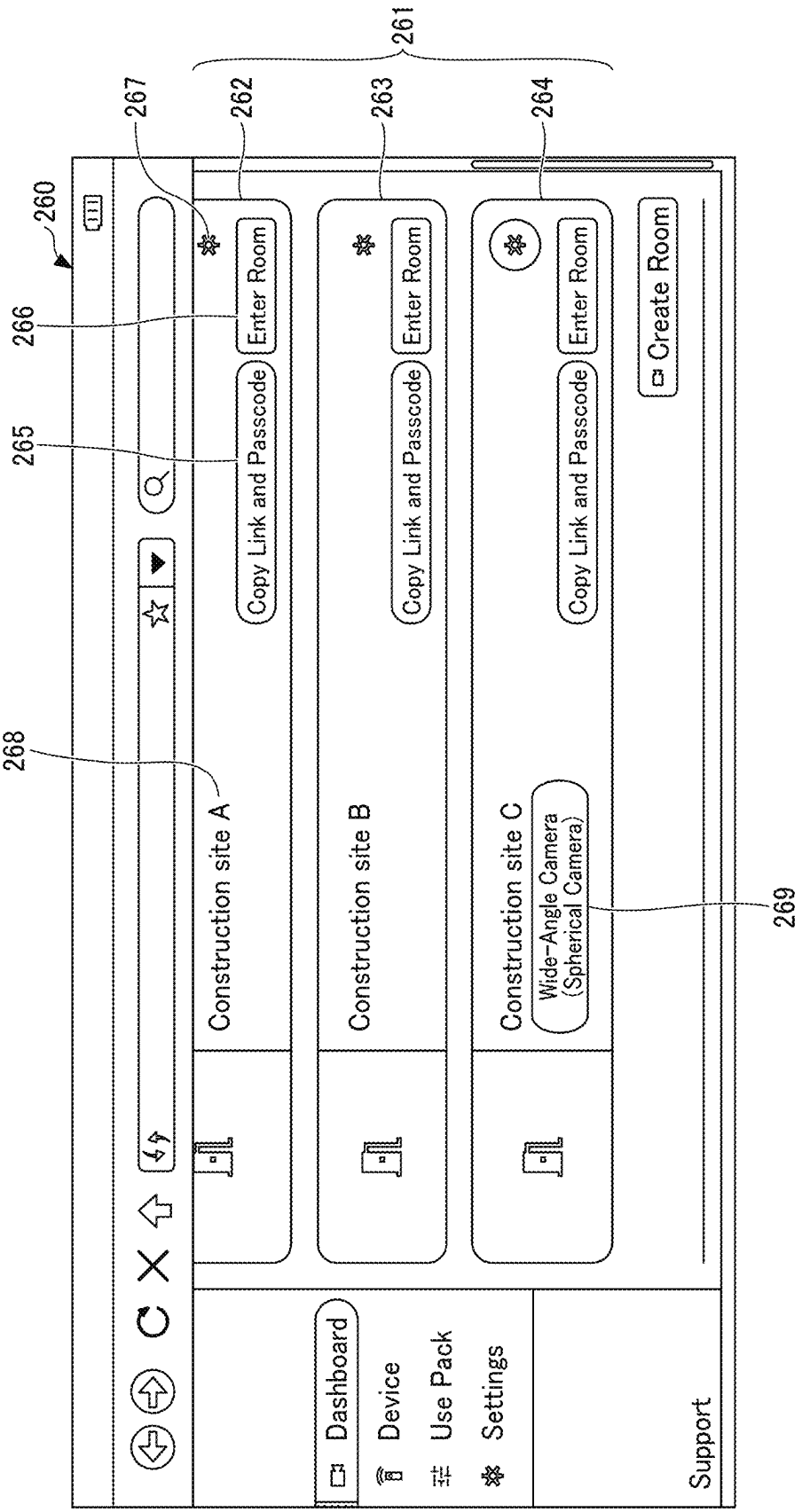

260
261
262
263
264
265
266
267
268
269
Dashboard
Device
Use Pack
Settings
Support
Construction site A
Construction site B
Construction site C
Copy Link and Passcode
Enter Room
Wide-Angle Camera (Spherical Camera)
Create Room

FIG. 23

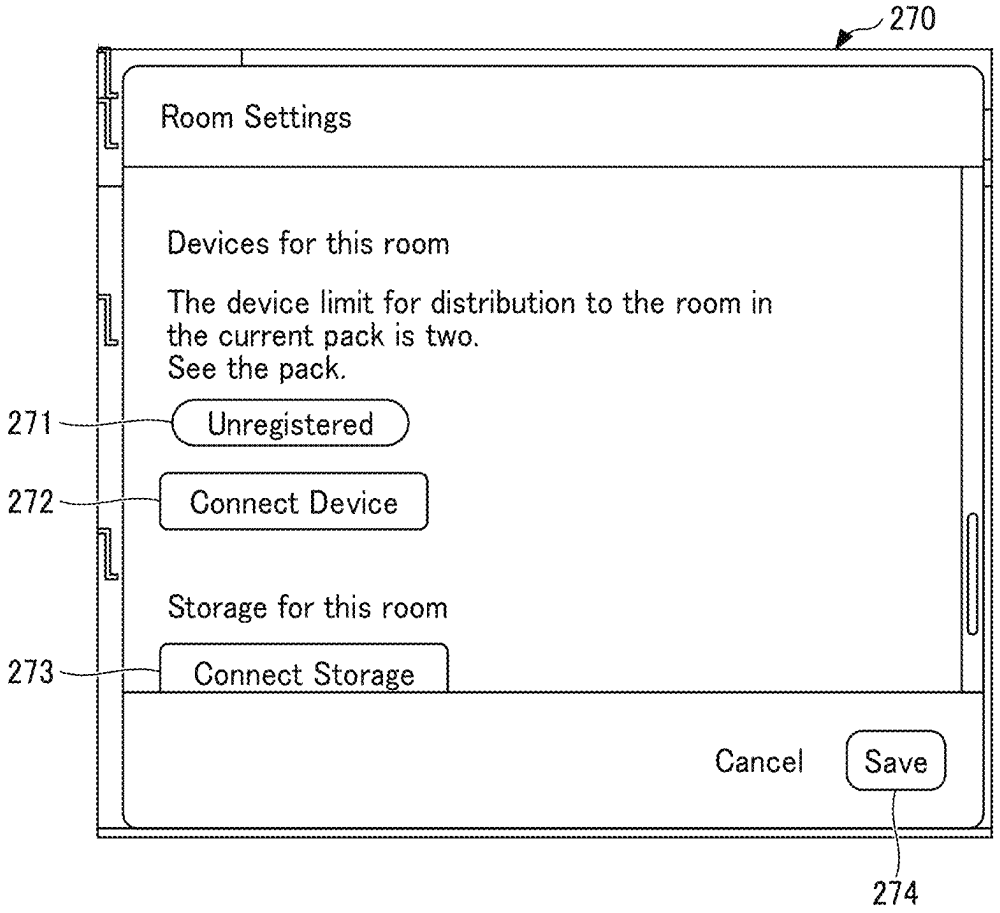
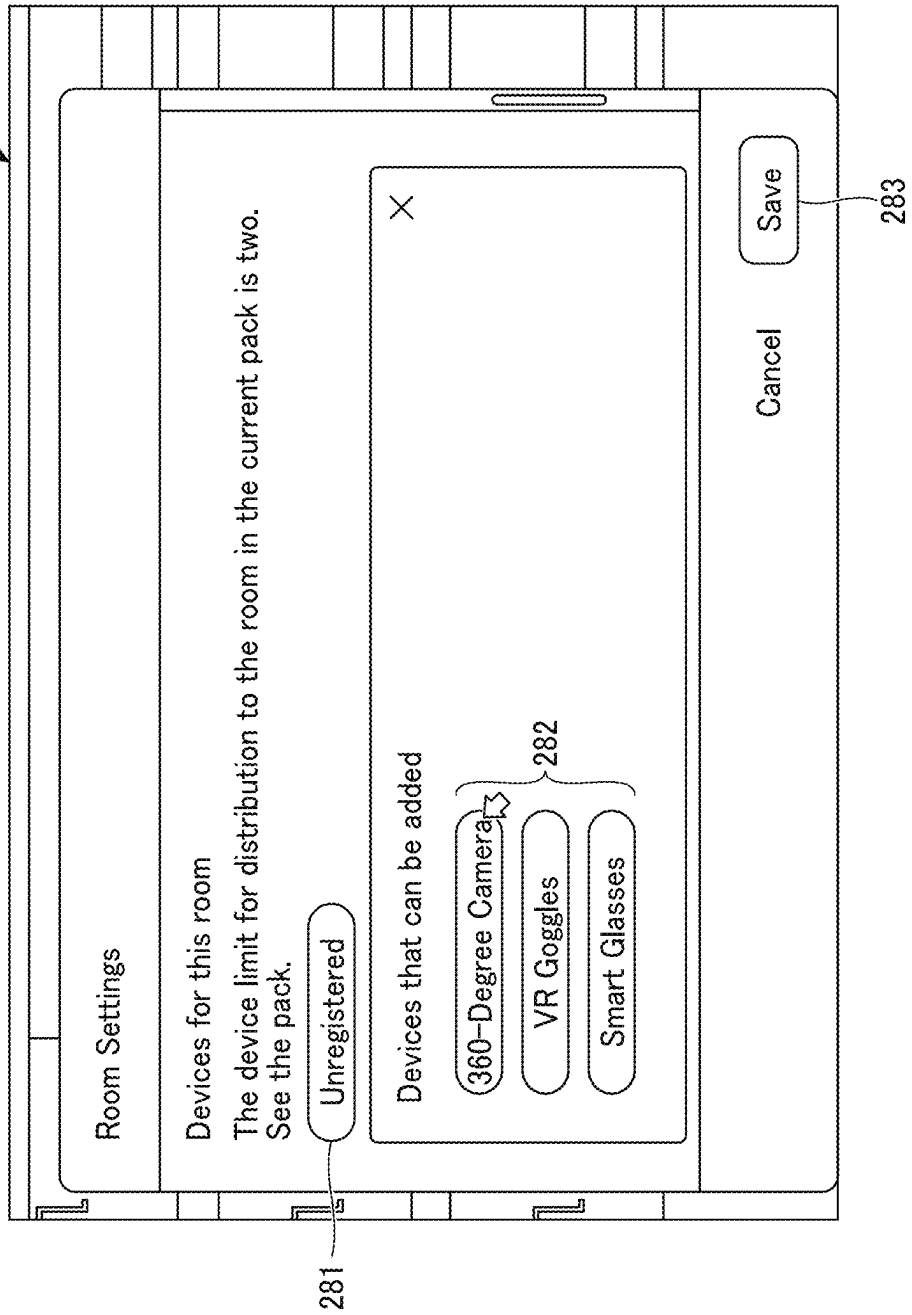

270
Room Settings
Devices for this room
The device limit for distribution to the room in the current pack is two.
See the pack.
271
Unregistered
272
Connect Device
Storage for this room
273
Connect Storage
Cancel
Save
274

FIG. 24


280
Room Settings
Devices for this room
The device limit for distribution to the room in the current pack is two.
See the pack.
Unregistered
281
Devices that can be added
360-Degree Camera
VR Goggles
Smart Glasses
282
Cancel
Save
283

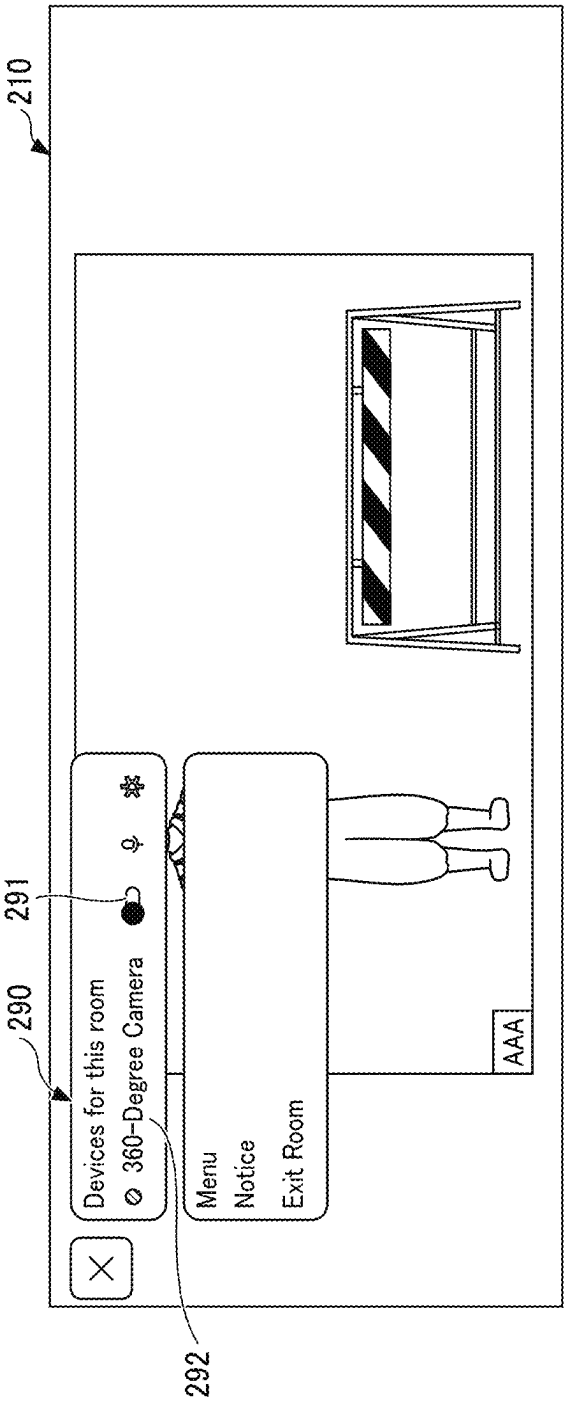


FIG. 25A

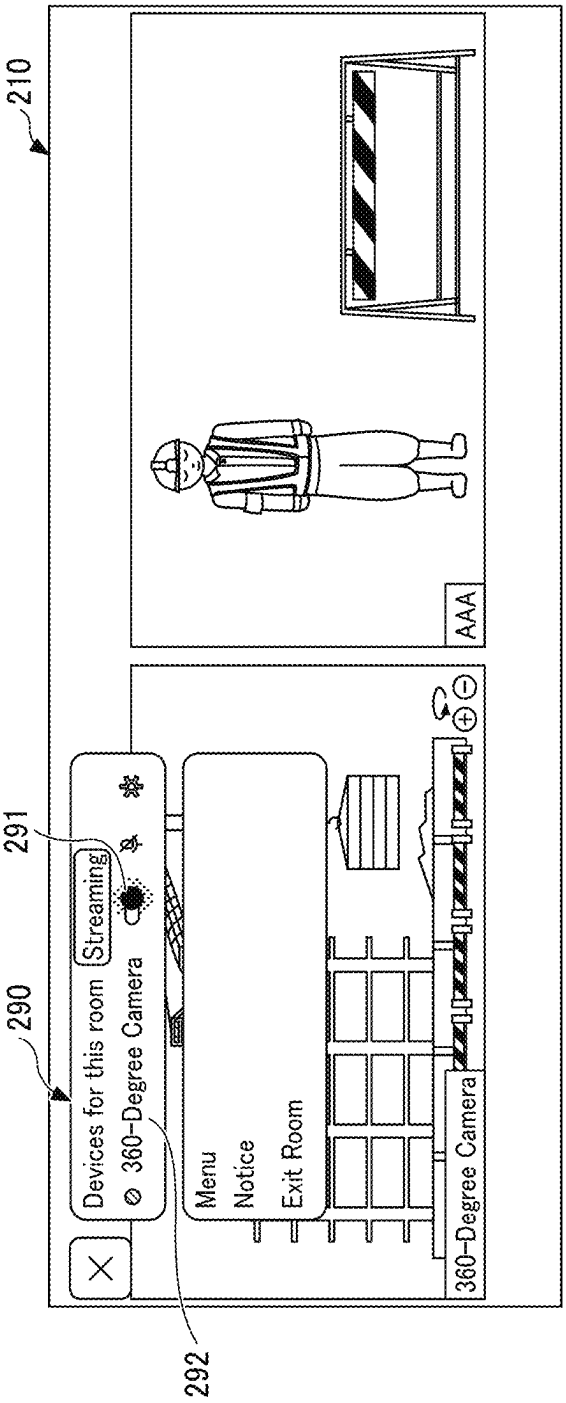


FIG. 25B

FIG. 26

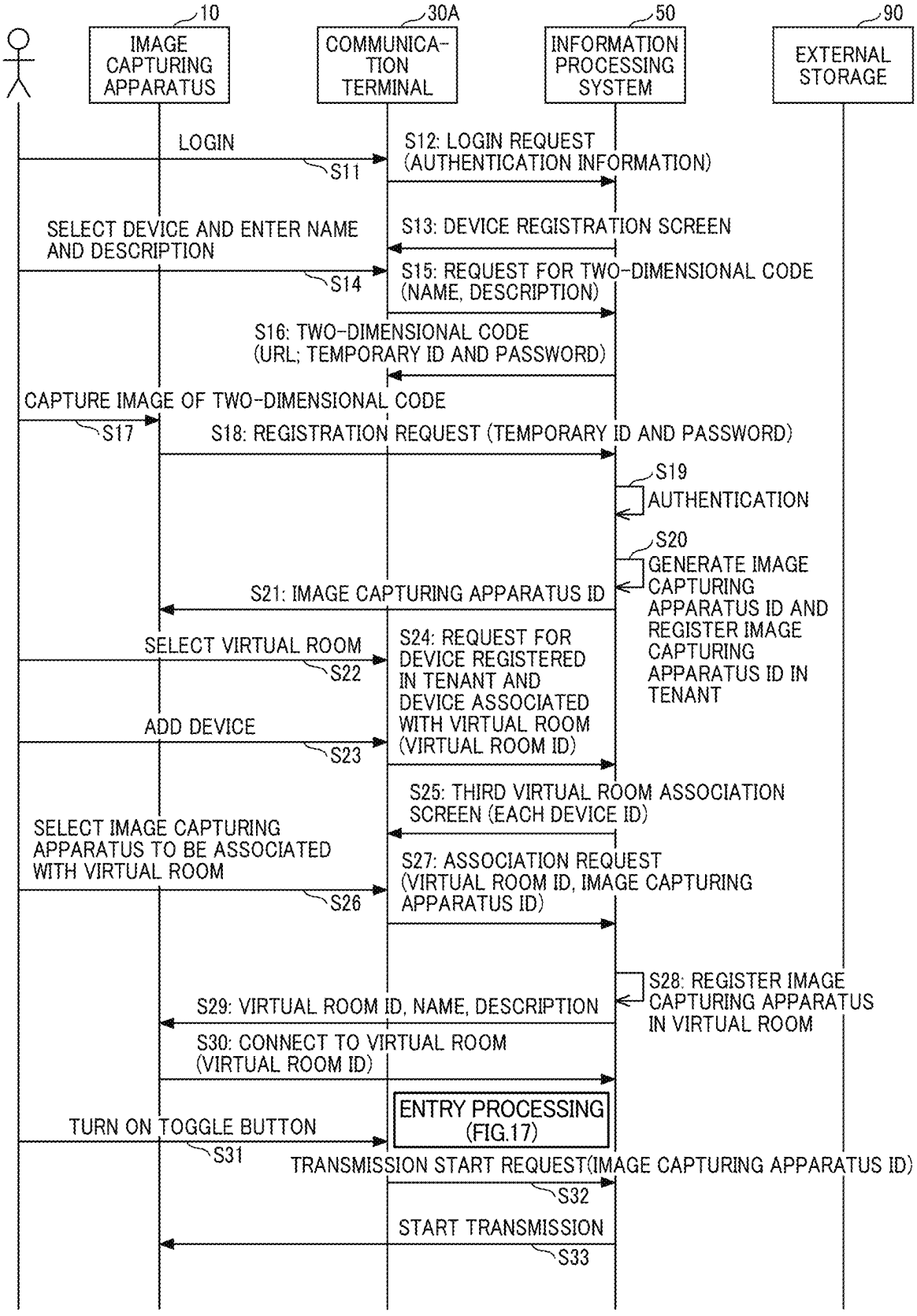

10
IMAGE CAPTURING APPARATUS
30A
COMMUNICATION TERMINAL
50
INFORMATION PROCESSING SYSTEM
90
EXTERNAL STORAGE
LOGIN
S11
S12: LOGIN REQUEST (AUTHENTICATION INFORMATION)
S13: DEVICE REGISTRATION SCREEN
SELECT DEVICE AND ENTER NAME AND DESCRIPTION
S14
S15: REQUEST FOR TWO-DIMENSIONAL CODE (NAME, DESCRIPTION)
S16: TWO-DIMENSIONAL CODE (URL; TEMPORARY ID AND PASSWORD)
CAPTURE IMAGE OF TWO-DIMENSIONAL CODE
S17
S18: REGISTRATION REQUEST (TEMPORARY ID AND PASSWORD)
S19
AUTHENTICATION
S20
GENERATE IMAGE CAPTURING APPARATUS ID AND REGISTER IMAGE CAPTURING APPARATUS ID IN TENANT
S21: IMAGE CAPTURING APPARATUS ID
SELECT VIRTUAL ROOM
S22
S24: REQUEST FOR DEVICE REGISTERED IN TENANT AND DEVICE ASSOCIATED WITH VIRTUAL ROOM (VIRTUAL ROOM ID)
ADD DEVICE
S23
S25: THIRD VIRTUAL ROOM ASSOCIATION SCREEN (EACH DEVICE ID)
SELECT IMAGE CAPTURING APPARATUS TO BE ASSOCIATED WITH VIRTUAL ROOM
S26
S27: ASSOCIATION REQUEST (VIRTUAL ROOM ID, IMAGE CAPTURING APPARATUS ID)
S28: REGISTER IMAGE CAPTURING APPARATUS IN VIRTUAL ROOM
S29: VIRTUAL ROOM ID, NAME, DESCRIPTION
S30: CONNECT TO VIRTUAL ROOM (VIRTUAL ROOM ID)
ENTRY PROCESSING (FIG.17)
TURN ON TOGGLE BUTTON
S31
TRANSMISSION START REQUEST(IMAGE CAPTURING APPARATUS ID)
S32
START TRANSMISSION
S33

FIG. 27

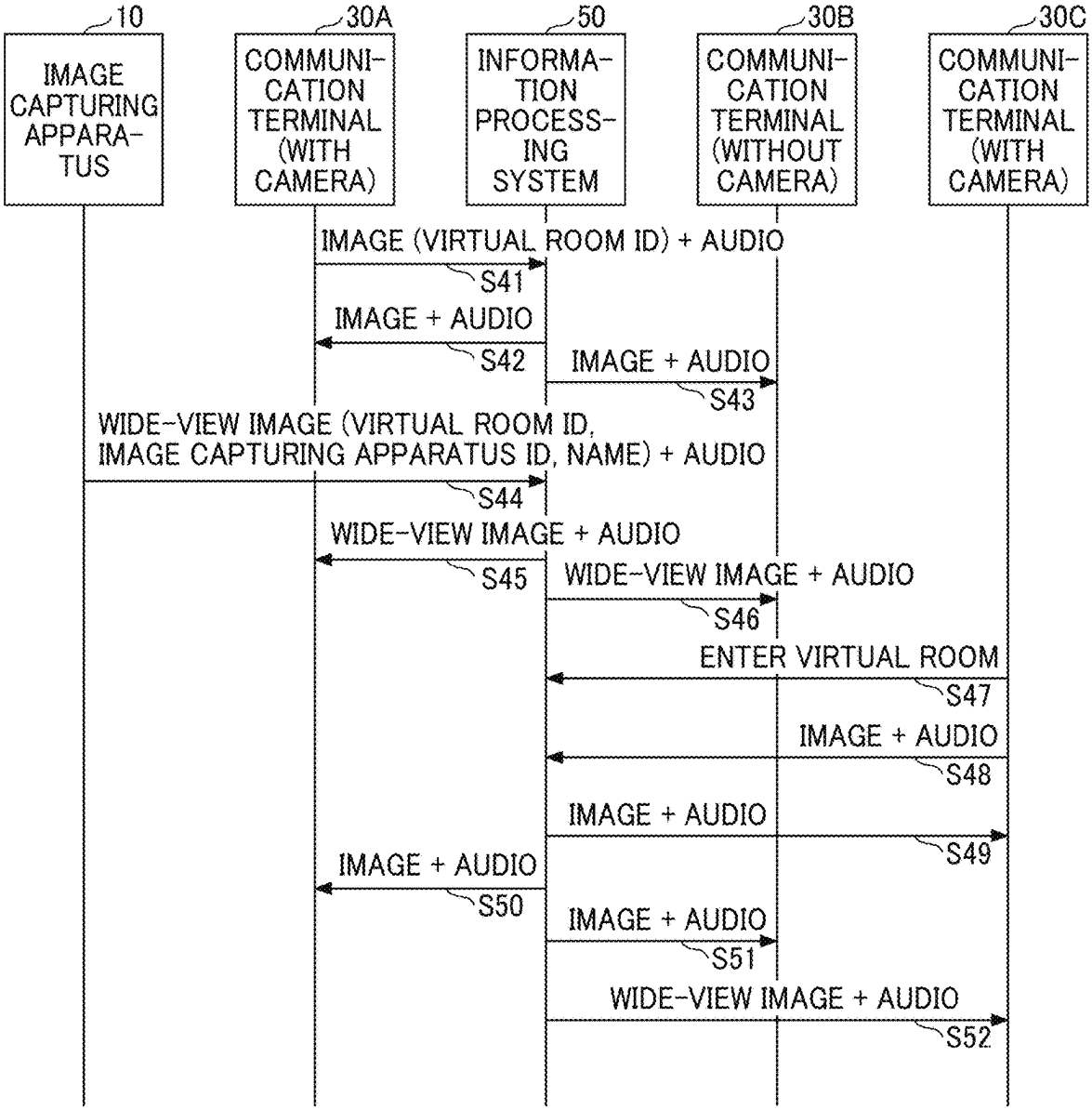

10
IMAGE CAPTURING APPARATUS
30A
COMMUNICATION TERMINAL (WITH CAMERA)
50
INFORMATION PROCESSING SYSTEM
30B
COMMUNICATION TERMINAL (WITHOUT CAMERA)
30C
COMMUNICATION TERMINAL (WITH CAMERA)
IMAGE (VIRTUAL ROOM ID) + AUDIO
S41
IMAGE + AUDIO
S42
IMAGE + AUDIO
S43
WIDE-VIEW IMAGE (VIRTUAL ROOM ID, IMAGE CAPTURING APPARATUS ID, NAME) + AUDIO
S44
WIDE-VIEW IMAGE + AUDIO
S45
WIDE-VIEW IMAGE + AUDIO
S46
ENTER VIRTUAL ROOM
S47
IMAGE + AUDIO
S48
IMAGE + AUDIO
S49
IMAGE + AUDIO
S50
IMAGE + AUDIO
S51
WIDE-VIEW IMAGE + AUDIO
S52

FIG. 28

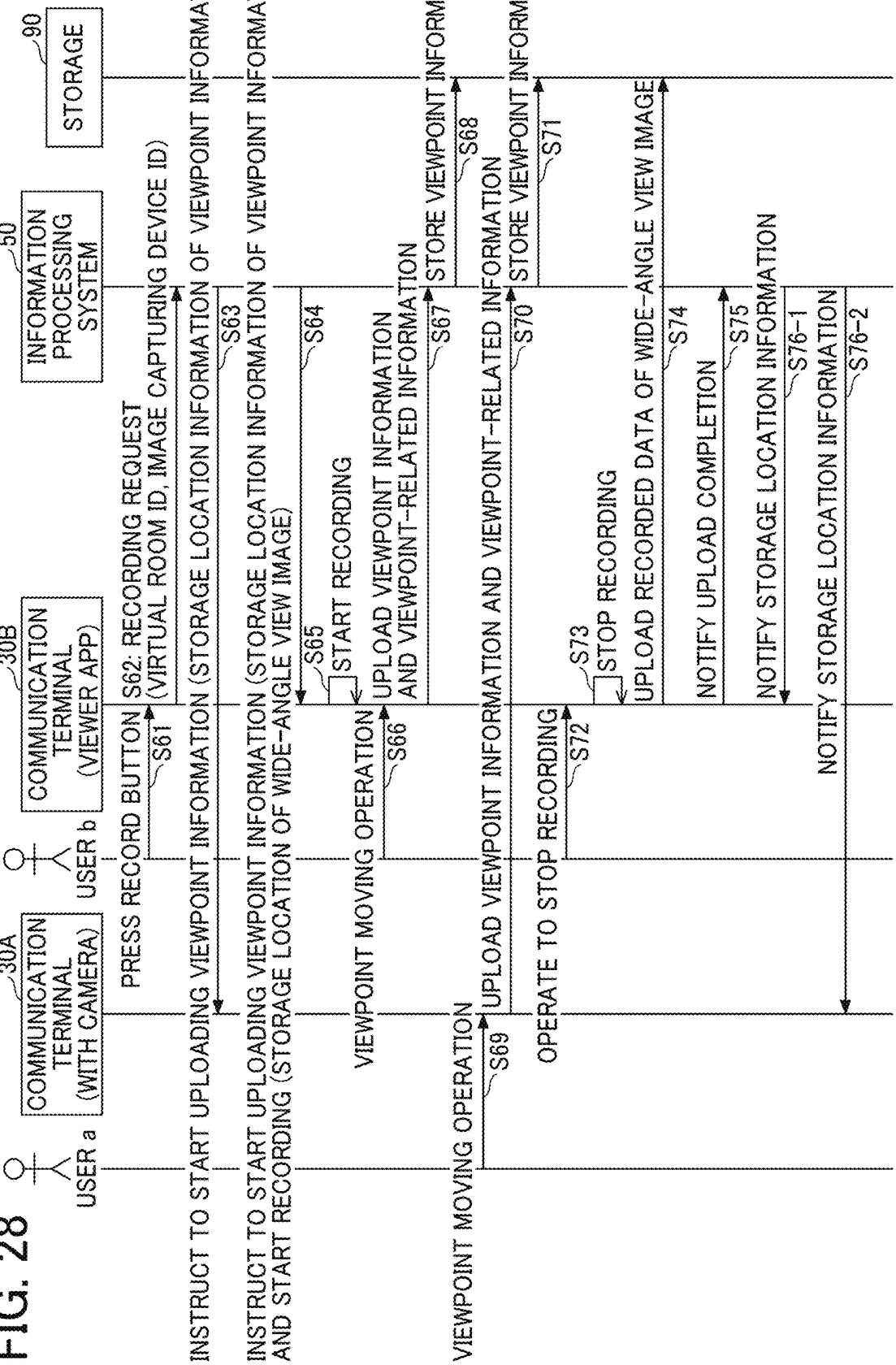

USER a
USER b
30A
COMMUNICATION TERMINAL (WITH CAMERA)
30B
COMMUNICATION TERMINAL (VIEWER APP)
50
INFORMATION PROCESSING SYSTEM
90
STORAGE
PRESS RECORD BUTTON
S61
S62: RECORDING REQUEST (VIRTUAL ROOM ID, IMAGE CAPTURING DEVICE ID)
INSTRUCT TO START UPLOADING VIEWPOINT INFORMATION (STORAGE LOCATION INFORMATION OF VIEWPOINT INFORMATION)
S63
INSTRUCT TO START UPLOADING VIEWPOINT INFORMATION (STORAGE LOCATION INFORMATION OF VIEWPOINT INFORMATION), AND START RECORDING (STORAGE LOCATION OF WIDE-ANGLE VIEW IMAGE)
S64
S65
START RECORDING
VIEWPOINT MOVING OPERATION
S66
UPLOAD VIEWPOINT INFORMATION AND VIEWPOINT-RELATED INFORMATION
S67
STORE VIEWPOINT INFORMATION
S68
VIEWPOINT MOVING OPERATION
S69
UPLOAD VIEWPOINT INFORMATION AND VIEWPOINT-RELATED INFORMATION
S70
STORE VIEWPOINT INFORMATION
S71
OPERATE TO STOP RECORDING
S72
S73
STOP RECORDING
UPLOAD RECORDED DATA OF WIDE-ANGLE VIEW IMAGE
S74
NOTIFY UPLOAD COMPLETION
S75
NOTIFY STORAGE LOCATION INFORMATION
S76-1
NOTIFY STORAGE LOCATION INFORMATION
S76-2

FIG. 29

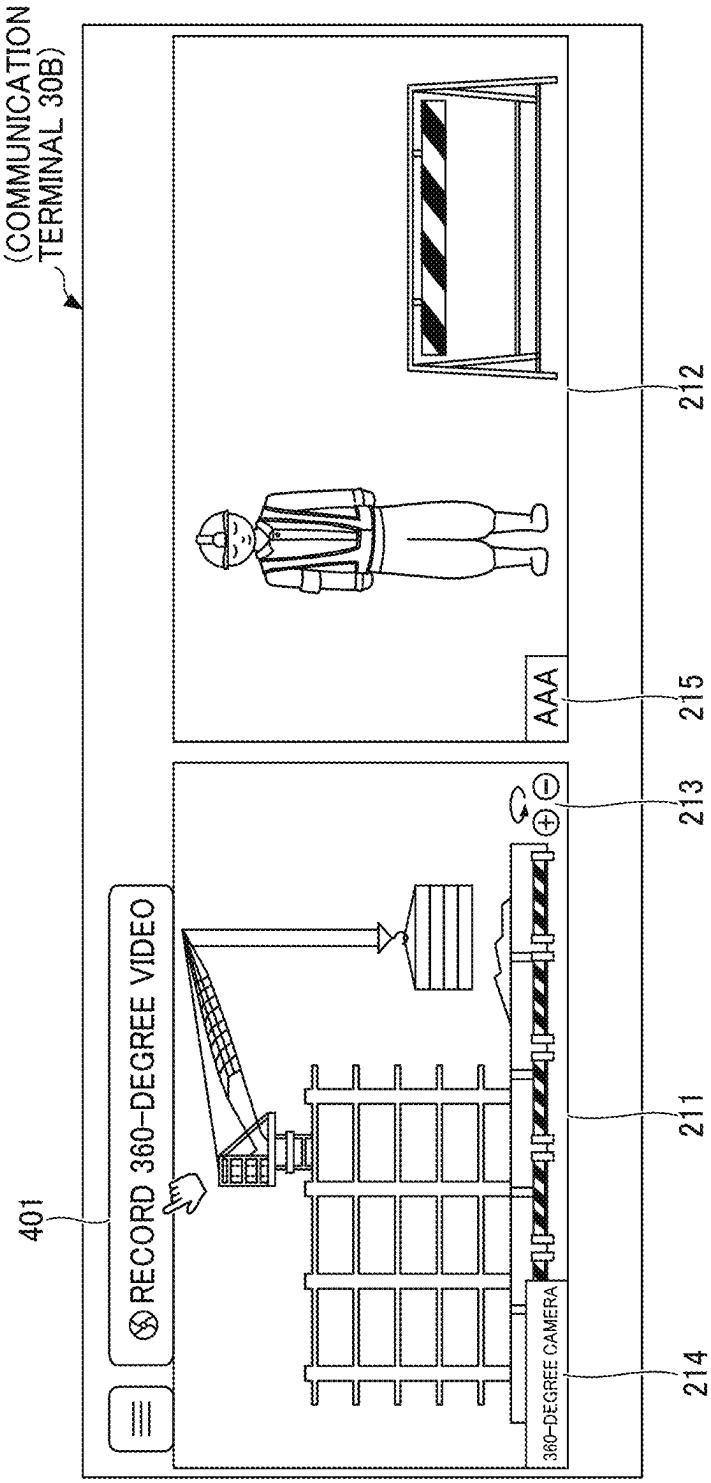
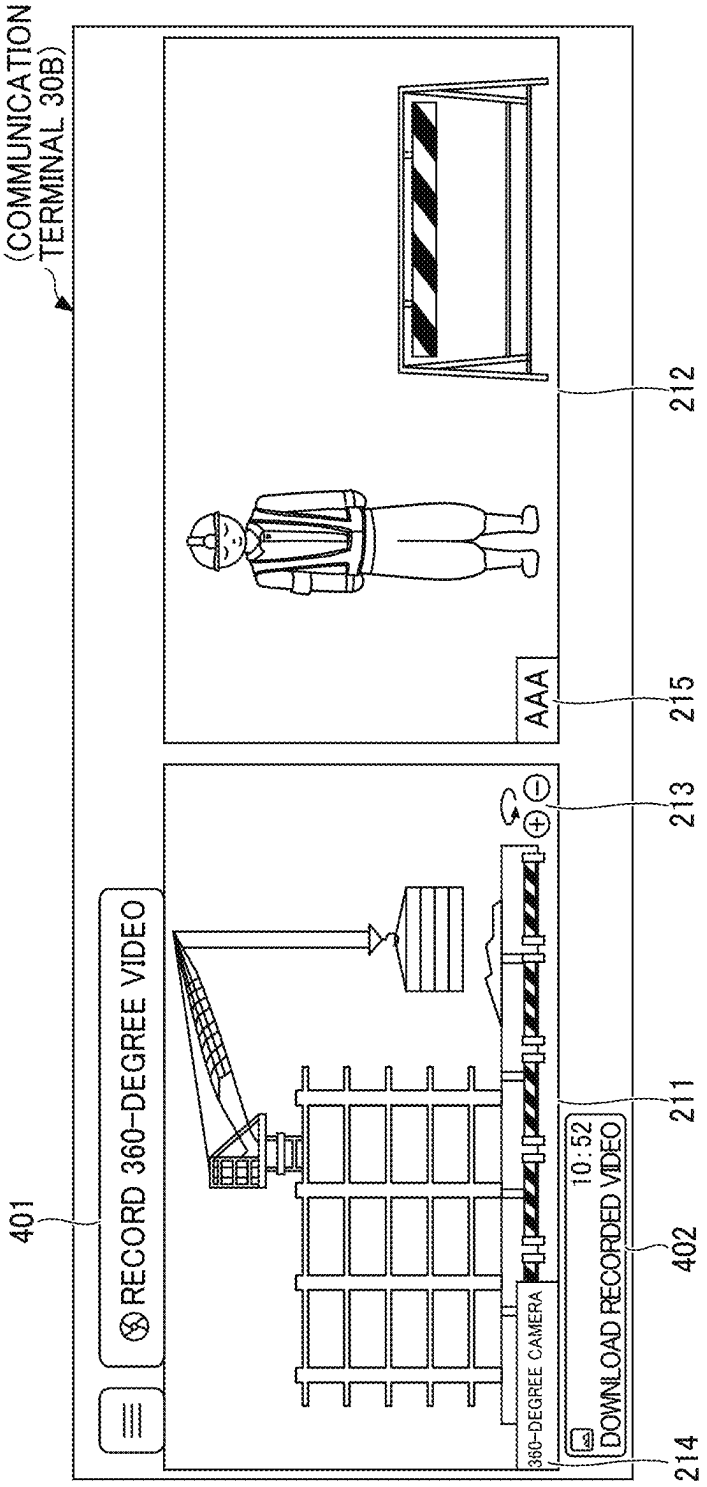

400
(COMMUNICATION TERMINAL 30B)
401
RECORD 360-DEGREE VIDEO
360-DEGREE CAMERA
AAA
211
212
213
214
215

FIG. 30


400
(COMMUNICATION TERMINAL 30B)
401
RECORD 360-DEGREE VIDEO
360-DEGREE CAMERA
10:52
DOWNLOAD RECORDED VIDEO
AAA
211
212
213
214
215
402

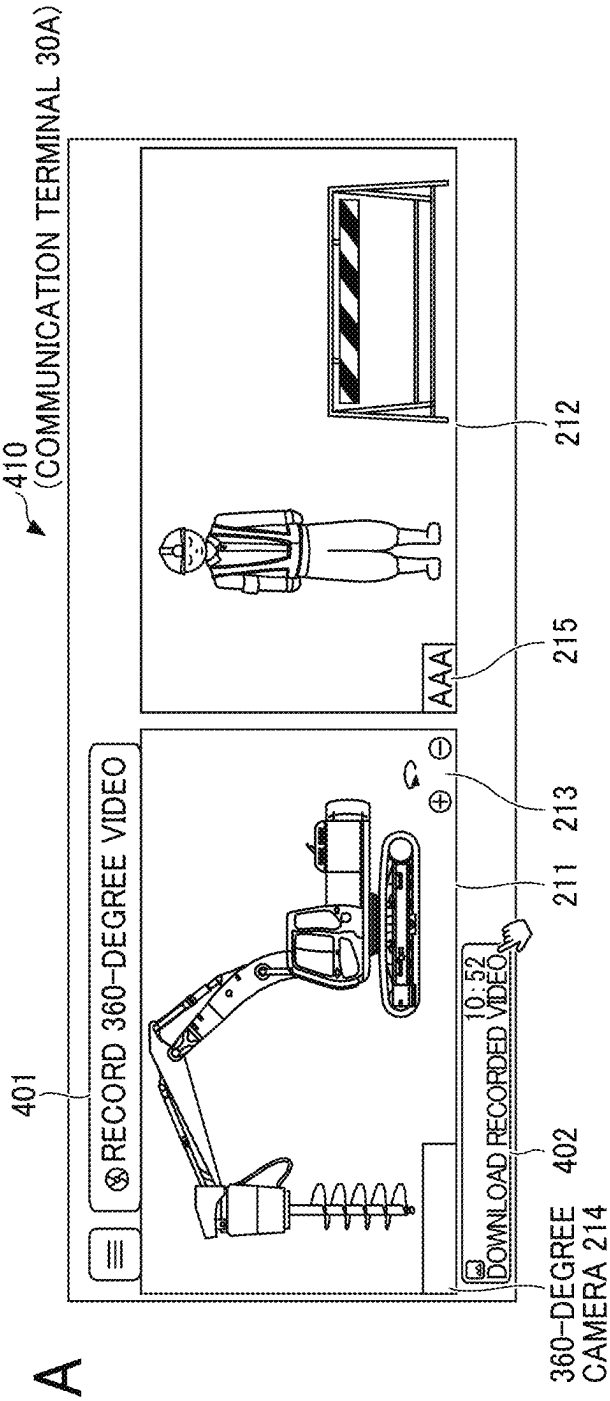

410
(COMMUNICATION TERMINAL 30A)
401
RECORD 360-DEGREE VIDEO
DOWNLOAD RECORDED VIDEO
10:52
AAA
212
215
213
211
402
360-DEGREE
CAMERA 214

FIG. 31A

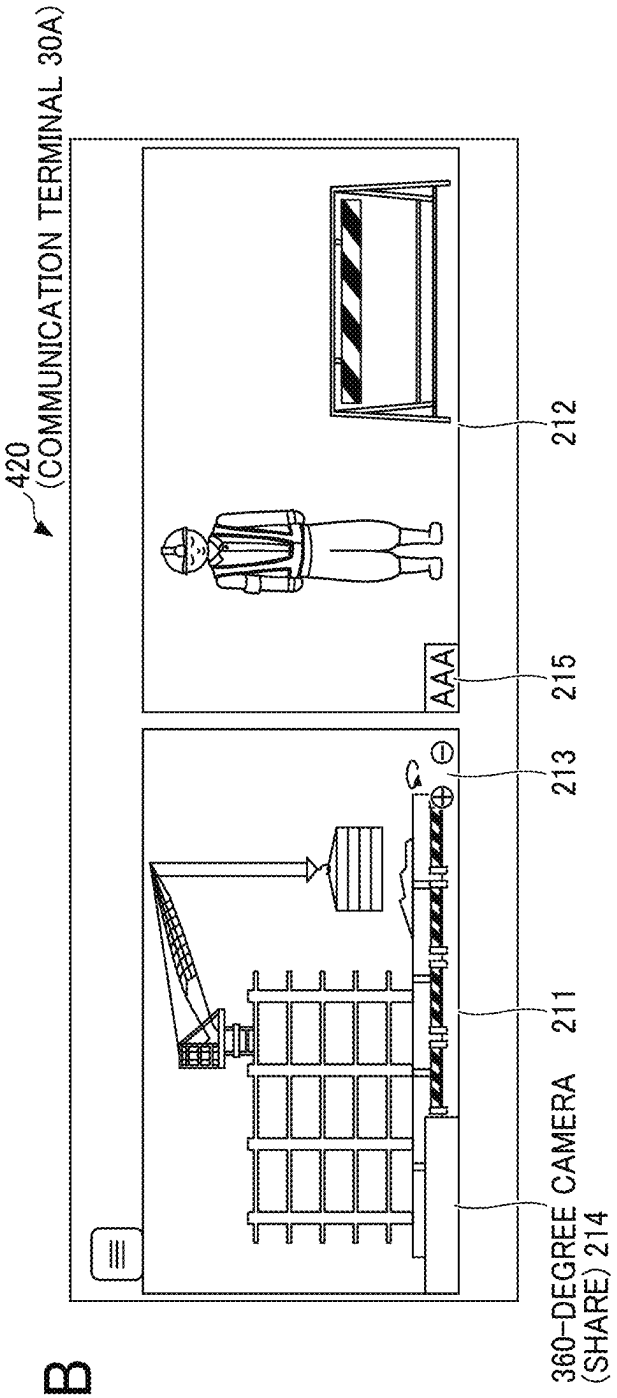

420
(COMMUNICATION TERMINAL 30A)
212
AAA
215
213
211
360-DEGREE CAMERA
(SHARE) 214

FIG. 31B

FIG. 32

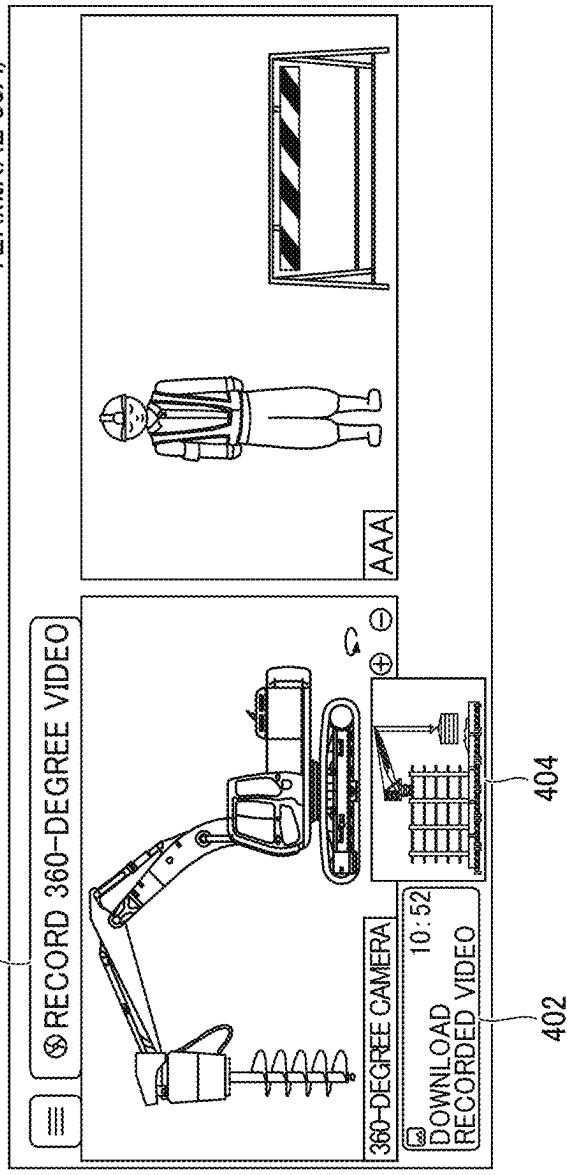

410
(COMMUNICATION TERMINAL 30A)
401
RECORD 360-DEGREE VIDEO
AAA
360-DEGREE CAMERA
10:52
DOWNLOAD RECORDED VIDEO
402
404

FIG. 33

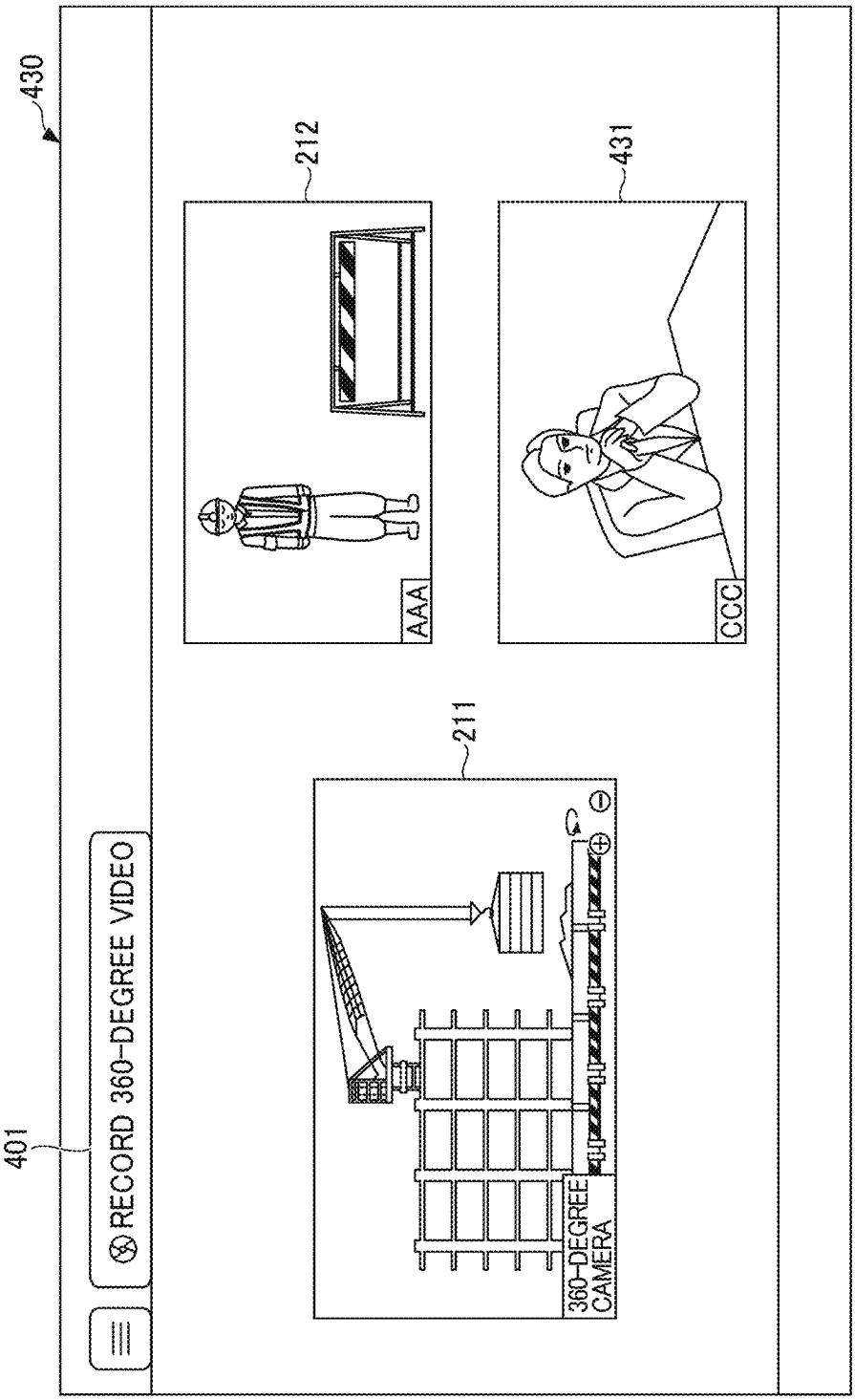

430
212
431
AAA
CCC
211
401
RECORD 360-DEGREE VIDEO
360-DEGREE CAMERA

FIG. 34

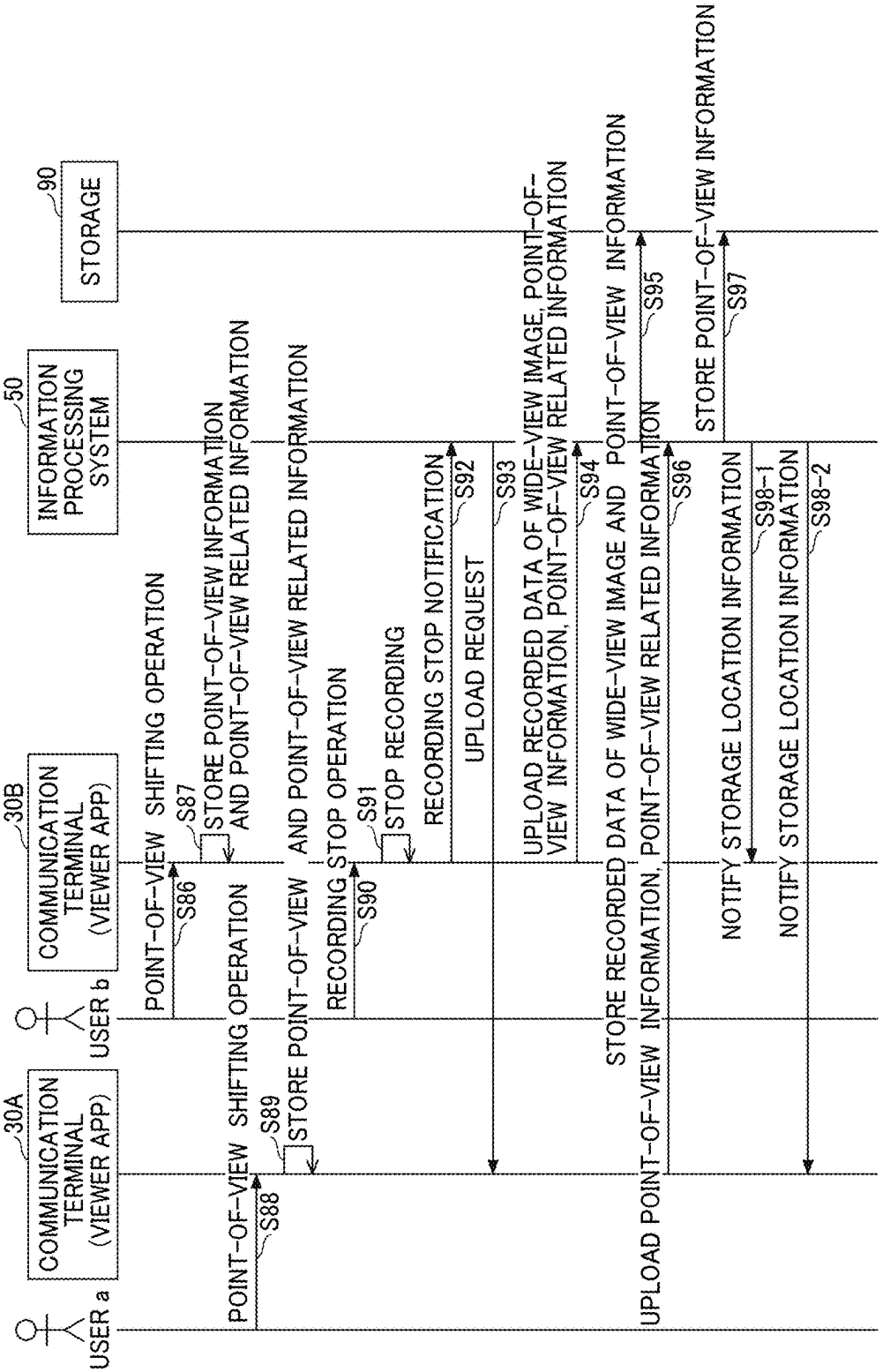

USER a
USER b
30A
COMMUNICATION TERMINAL (VIEWER APP)
30B
COMMUNICATION TERMINAL (VIEWER APP)
50
INFORMATION PROCESSING SYSTEM
90
STORAGE
POINT-OF-VIEW SHIFTING OPERATION
S86
STORE POINT-OF-VIEW INFORMATION AND POINT-OF-VIEW RELATED INFORMATION
S87
POINT-OF-VIEW SHIFTING OPERATION
S88
STORE POINT-OF-VIEW AND POINT-OF-VIEW RELATED INFORMATION
S89
RECORDING STOP OPERATION
S90
STOP RECORDING
S91
RECORDING STOP NOTIFICATION
S92
UPLOAD REQUEST
S93
UPLOAD RECORDED DATA OF WIDE-VIEW IMAGE, POINT-OF-VIEW INFORMATION, POINT-OF-VIEW RELATED INFORMATION
S94
STORE RECORDED DATA OF WIDE-VIEW IMAGE AND POINT-OF-VIEW INFORMATION
S95
UPLOAD POINT-OF-VIEW INFORMATION, POINT-OF-VIEW RELATED INFORMATION
S96
STORE POINT-OF-VIEW INFORMATION
S97
NOTIFY STORAGE LOCATION INFORMATION
S98-1
NOTIFY STORAGE LOCATION INFORMATION
S98-2

FIG. 35

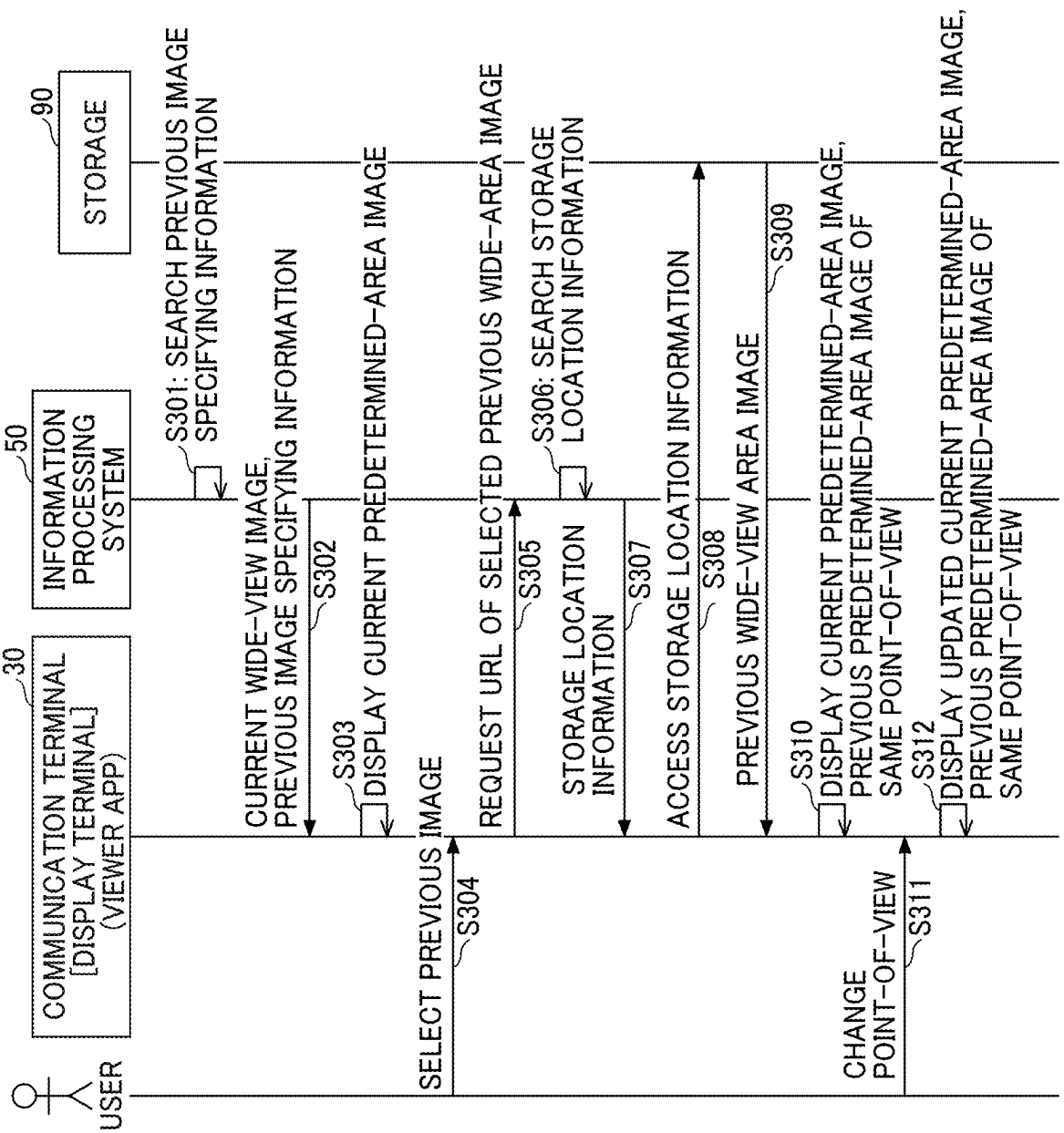

USER
30
COMMUNICATION TERMINAL [DISPLAY TERMINAL] (VIEWER APP)
50
INFORMATION PROCESSING SYSTEM
90
STORAGE
S301: SEARCH PREVIOUS IMAGE SPECIFYING INFORMATION
CURRENT WIDE-VIEW IMAGE, PREVIOUS IMAGE SPECIFYING INFORMATION
S302
S303
DISPLAY CURRENT PREDETERMINED-AREA IMAGE
SELECT PREVIOUS IMAGE
S304
REQUEST URL OF SELECTED PREVIOUS WIDE-AREA IMAGE
S305
S306: SEARCH STORAGE LOCATION INFORMATION
STORAGE LOCATION INFORMATION
S307
ACCESS STORAGE LOCATION INFORMATION
S308
PREVIOUS WIDE-VIEW AREA IMAGE
S309
S310
DISPLAY CURRENT PREDETERMINED-AREA IMAGE, PREVIOUS PREDETERMINED-AREA IMAGE OF SAME POINT-OF-VIEW
CHANGE POINT-OF-VIEW
S311
S312
DISPLAY UPDATED CURRENT PREDETERMINED-AREA IMAGE, PREVIOUS PREDETERMINED-AREA IMAGE OF SAME POINT-OF-VIEW

FIG. 36

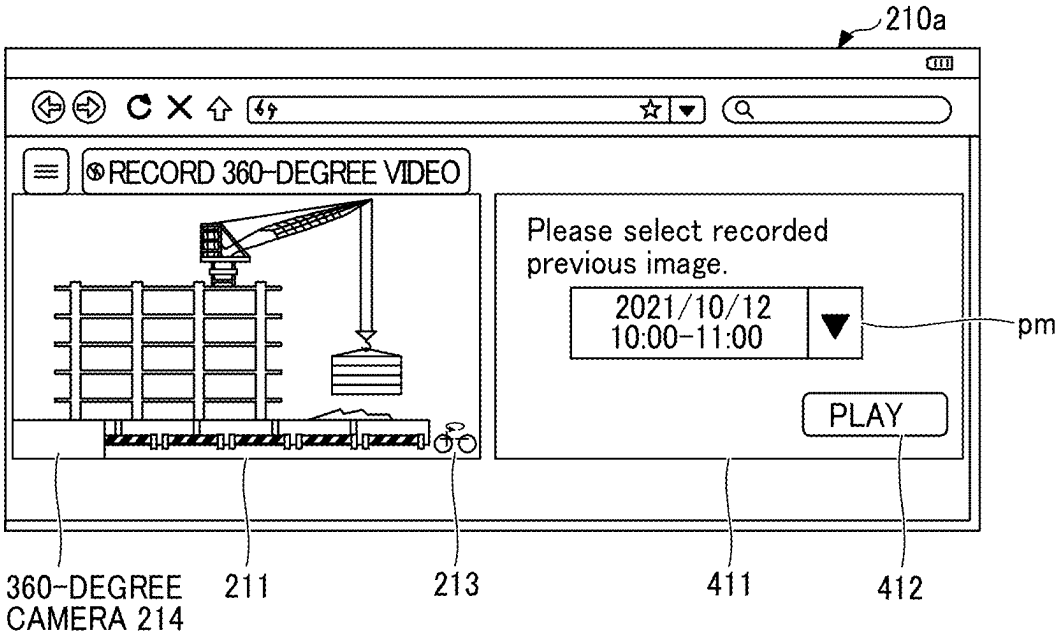

210a
RECORD 360-DEGREE VIDEO
Please select recorded previous image.
2021/10/12 10:00-11:00
pm
PLAY
360-DEGREE CAMERA 214
211
213
411
412

FIG. 37

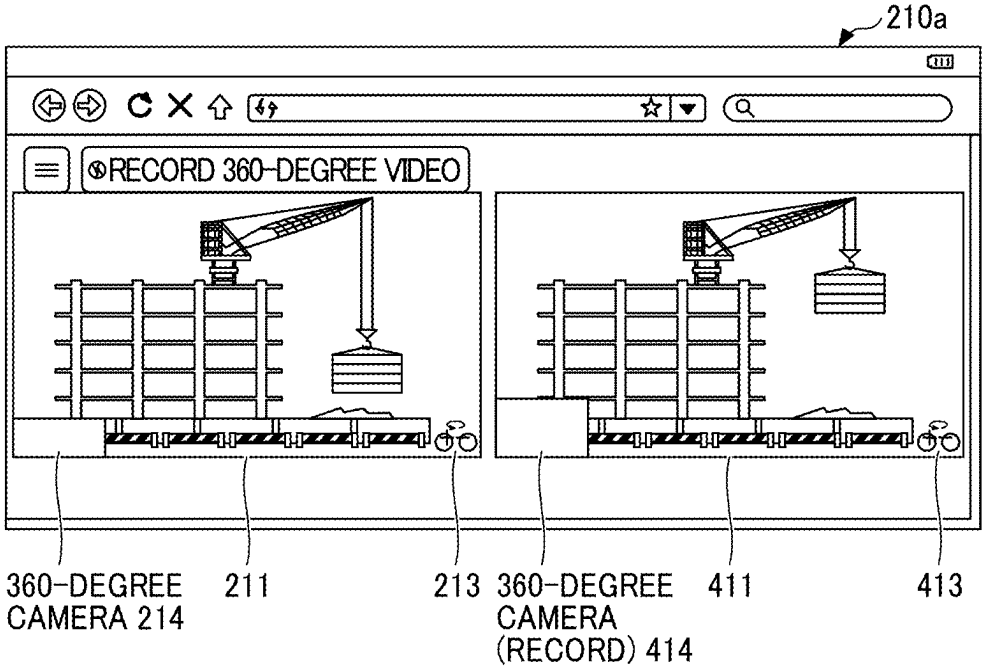

210a
RECORD 360-DEGREE VIDEO
360-DEGREE CAMERA 214
211
213
360-DEGREE CAMERA (RECORD) 414
411
413

FIG. 38

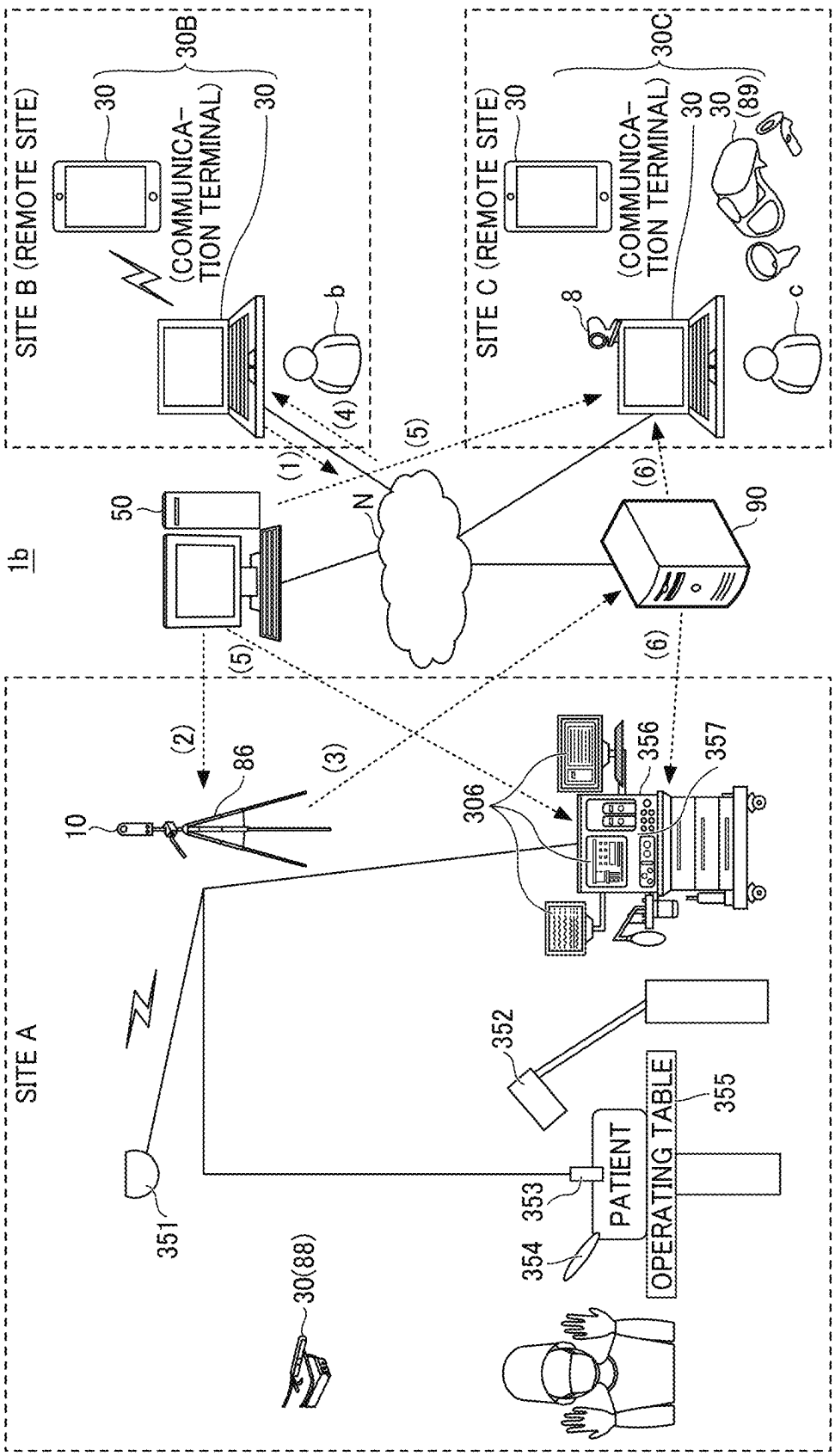
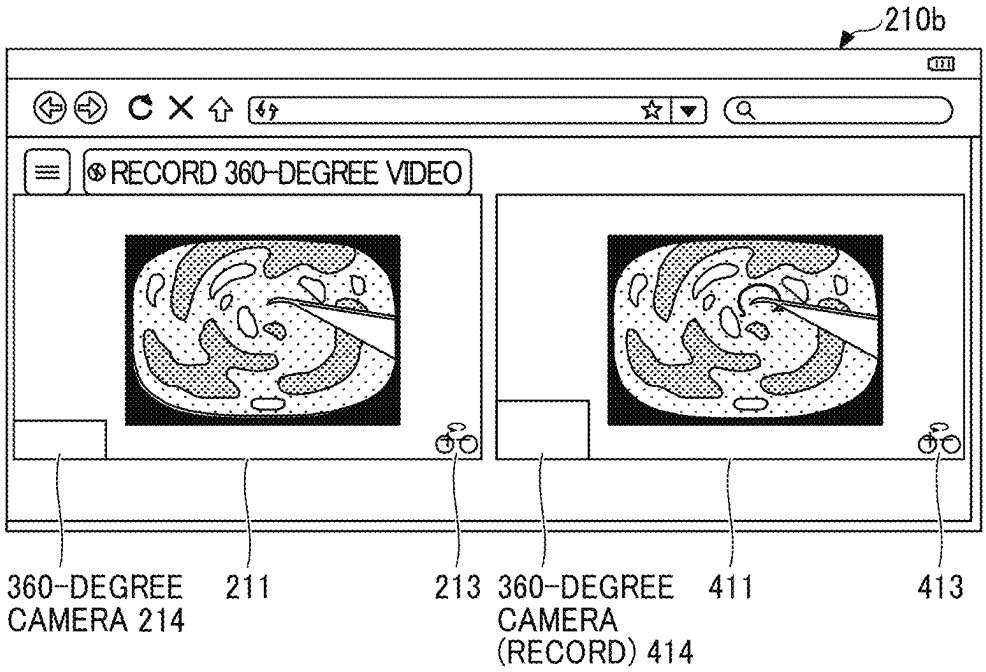

SITE A
SITE B (REMOTE SITE)
SITE C (REMOTE SITE)
1b
30B
30C
30
(COMMUNICATION TERMINAL)
50
N
90
10
86
306
356
357
352
355
353
354
351
30(88)
PATIENT
OPERATING TABLE
(1)
(2)
(3)
(4)
(5)
(6)
(89)
b
c
8

FIG. 39


210b
RECORD 360-DEGREE VIDEO
360-DEGREE CAMERA 214
211
213
360-DEGREE CAMERA (RECORD) 414
411
413

DISPLAY TERMINAL, COMMUNICATION SYSTEM, AND DISPLAY METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application is based on and claims priority pursuant to 35 U.S.C. § 119(a) to Japanese Patent Application No. 2022-191974, filed on Nov. 30, 2022, and 2023-156333, filed on Sep. 21, 2023, in the Japan Patent Office, the entire disclosure of which is hereby incorporated by reference herein.

BACKGROUND

Technical Field

The present disclosure relates to a display terminal, a communication system, and a display method.

Related Art

A communication system transmits images and audio from one site to one or more other sites in real time to allow remote users to perform remote communication using the images and audio. A known example of such an image is a wide-field-of-view image having a wide viewing angle and captured in a wide imaging range as an imaging range including even an area that is difficult for a normal angle of view to cover. The wide-field-of-view image is hereinafter referred to as a "wide-view image". Examples of the wide-view image include a 360-degree image that is a captured image of an entire 360-degree view. The 360-degree image is also referred to as a spherical image, an omnidirectional image, or an "all-around" image. A user operates a communication terminal to change a virtual point of view for a predetermined area in a wide-view image displayed on a display screen of the communication terminal. As a result, the user can view a different predetermined area in the wide-view image after changing the virtual point of view.

A wide-view image related to a moving image obtained by capturing images of a work site or the like is recorded when distributed to predetermined sites. Users at the predetermined sites can play back, display, and view the recorded wide-view image later. For example, video is captured by a camera. A current image and a previous image of the same area in the video are displayed to a user to allow the user to compare the same location between the current image and the previous image.

A wide-view image displayed on a display terminal (or communication terminal) appears curved and makes the user feel confused. Accordingly, a predetermined-area image, which represents a predetermined area of the wide-view image, is displayed. Thus, for example, when the current image and the previous image are wide-view images, different predetermined-area images are displayed if the predetermined area to be displayed on the display terminal differs, even though the current image and the previous image are captured images of the same location. As a result, the images may be difficult to compare with each other.

SUMMARY

According to an embodiment of the present disclosure, a display terminal includes circuitry. The circuitry displays a first predetermined-area image on a display screen, the first predetermined-area image representing a predetermined area in a first wide-view image having been captured at a given location on a first date and time; and displays a second predetermined-area image on the display screen, the second predetermined-area image being related to the predetermined area in a second wide-view image, the second wide-view image having been captured at the given location and captured on a second date and time different from the first date and time.

According to an embodiment of the present disclosure, a communication system includes an information processing system and a display terminal. The information processing system distributes a wide-view image. The display terminal receives and displays the wide-view image that is distributed. The information processing system includes first circuitry. The first circuitry distributes a first wide-view image and a second wide-view image. The first wide-view image and the second wide-view image have been captured at a given location on different dates and times. The display terminal includes second circuitry. The second circuitry displays a first predetermined-area image on a display screen, the first predetermined-area image representing a predetermined area in the first wide-view image; and displays a second predetermined-area image on the display screen, the second predetermined-area image being related to the predetermined area in the second wide-view image.

According to an embodiment of the present disclosure, a display method is executed. The display method includes displaying a first predetermined-area image on a display screen, the first predetermined-area image representing a predetermined area in a first wide-view image having been captured at a given location on a first date and time; and displaying a second predetermined-area image on the display screen, the second predetermined-area image being related to the predetermined area in a second wide-view image, the second wide-view image having been captured at the given location and captured on a second date and time different from the first date and time.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of embodiments of the present disclosure and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawings, wherein:

FIG. **1** is a diagram illustrating an example of remote communication using a wide-view image;

FIG. **2** is a diagram illustrating an example schematic configuration of a communication system;

FIG. **3** is a diagram illustrating an example hardware configuration of an image capturing apparatus;

FIG. **4** is a diagram illustrating an example hardware configuration of a communication terminal and an information processing system;

FIGS. **5**A, **5**B, and **5**C are a left side view, a front view, and a plan view of the image capturing apparatus according to an embodiment of the present disclosure, respectively;

FIG. **6** is an illustration for explaining how a user uses the image capturing apparatus, according to an embodiment of the present disclosure;

FIGS. **7**A, **7**B, and **7**C are views illustrating a hemispherical image (front side) captured by the image capturing apparatus, a hemispherical image (back side) captured by the image capturing apparatus, and an image in equirectangular projection, respectively, according to an embodiment of the present disclosure;

FIG. **8**A is a conceptual diagram illustrating an example of how the image in equirectangular projection is mapped to a surface of a sphere, according to an embodiment of the present disclosure;

FIG. **8**B is a view illustrating a spherical image, according to an embodiment of the present disclosure;

FIG. **9** is a view illustrating positions of a virtual camera and a predetermined area in a case where the spherical image is of a three-dimensional sphere according to an embodiment of the present disclosure;

FIG. **10**A is a perspective view of the virtual camera and the predetermined area illustrated in FIG. **9** according to an embodiment of the present disclosure;

FIG. **10**B is a view illustrating a predetermined-area image obtained in the state illustrated in FIG. **10**A and displayed on a display according to an embodiment of the present disclosure;

FIG. **10**C is a view of a predetermined area obtained by changing the point of view of the virtual camera illustrated in FIG. **10**A according to an embodiment of the present disclosure;

FIG. **10**D is a view illustrating a predetermined-area image obtained in the state illustrated in FIG. **10**C and displayed on the display according to an embodiment of the present disclosure;

FIG. **11** is a view illustrating a relationship between predetermined-area information and an image of the predetermined area according to an embodiment of the present disclosure;

FIG. **12** is a view illustrating a point in a three-dimensional Euclidean space defined in spherical coordinates, according to an embodiment of the present disclosure;

FIG. **13** is a diagram illustrating an example functional configuration of the communication system;

FIGS. **14**A and **14**B are conceptual diagrams illustrating image management information stored in an image management information storage unit according to an embodiment of the present disclosure;

FIGS. **15**A and **15**B are conceptual diagrams illustrating virtual room information stored in a virtual room information storage unit and tenant information stored in a tenant information storage unit, respectively, according to an embodiment of the present disclosure;

FIG. **16** is a conceptual diagram of point-of-view related information stored in a point-of-view related information storage unit according to an embodiment of the present disclosure;

FIG. **17**A is a view illustrating an example of a room entry screen;

FIG. **17**B is a view illustrating an example of an image viewing screen displayed on the communication terminal in response to the user entering a virtual room;

FIG. **18** is a sequence diagram illustrating an example process in which the user (or the communication terminal) enters the virtual room;

FIG. **19** is a view illustrating an example of a device registration screen displayed on the communication terminal;

FIG. **20**A is a view illustrating an example of an image capturing apparatus registration dialog;

FIG. **20**B is a view illustrating an example of a two-dimensional code screen;

FIG. **21** is a view illustrating an example of a virtual reality (VR) goggles registration screen displayed in response to the pressing of a VR goggles registration button;

FIG. **22** is a view illustrating an example of a first virtual room association screen for associating an image capturing apparatus with a virtual room;

FIG. **23** is a view illustrating an example of a second virtual room association screen;

FIG. **24** is a view illustrating an example of a third virtual room association screen;

FIGS. **25**A and **25**B are views illustrating examples of a wide-view image transmission control dialog displayed on the communication terminal;

FIG. **26** is a sequence diagram illustrating an example procedure in which the user registers the image capturing apparatus in a virtual room;

FIG. **27** is a sequence diagram illustrating an example process for sharing a wide-view image;

FIG. **28** is a sequence diagram illustrating an example process in which the user uses the communication terminal to issue an image capturing request to the image capturing apparatus in the sharing of a wide-view image;

FIG. **29** is a view illustrating an example of an image viewing screen displayed on the communication terminal;

FIG. **30** is a view illustrating an example of the image viewing screen on which a download button is displayed in response to the pressing of an image capturing button on the communication terminal;

FIG. **31**A is an illustration of an image viewing screen displayed before the user presses the download button;

FIG. **31**B is an illustration of an image viewing screen displayed after the user presses the download button;

FIG. **32** is a view illustrating an example of the image viewing screen on which a thumbnail image is displayed;

FIG. **33** is a view illustrating an example of an image viewing screen including three image fields;

FIG. **34** is a sequence diagram illustrating a modification of the process in which the user uses the communication terminal to issue an image capturing request to the image capturing apparatus in the sharing of a wide-view image;

FIG. **35** is a sequence diagram illustrating a process in which the user views a current image and a previous image that is stored in a storage according to an embodiment of the present disclosure;

FIG. **36** is a view illustrating an example of an image viewing screen for selecting a previous image during display of a current predetermined-area image;

FIG. **37** is a view illustrating an example of an image viewing screen for displaying a previous predetermined-area image having the same point of view as the current predetermined-area image during display of the current predetermined-area image;

FIG. **38** is a diagram illustrating an example of remote communication using the communication system in telemedicine; and

FIG. **39** is a view illustrating an example of an image viewing screen for use in telemedicine for displaying a previous predetermined-area image having the same point of view as a current predetermined-area image during display of the current predetermined-area image.

The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted. Also, identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION

In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity.

However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have a similar function, operate in a similar manner, and achieve a similar result.

Referring now to the drawings, embodiments of the present disclosure are described below. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

An information processing system and an image transmission method performed by the information processing system according to an embodiment of the present disclosure will be described below.

Example of Remote Communication

FIG. **1** is a diagram illustrating an example of remote communication using a wide-view image. In FIG. **1**, communication takes place across three sites, namely, a site A, a site B, and a site C, via an information processing system **50**. Three sites are merely an example, and communication may be performed across two sites or four or more sites.

In an example, the site A is a construction site. The sites B and C are any sites across which a wide-view image can be communicated. In an example, the sites B and C are offices. An image capturing apparatus **10** is placed at the site A. In an example, the image capturing apparatus **10** can capture an image of an object and surroundings to generate a wide-view image. Examples of the wide-view image include a wide-view image called a spherical image, and a wide-view image with a wide angle of view ranging from, for example, 180 degrees to 360 degrees in the vertical or horizontal direction. The term "image capturing apparatus" can be interchangeably used with the term "imaging apparatus" or "apparatus used for imaging". An image with a wide angle of view is hereinafter simply referred to as a "wide-view image". Communication terminals **30**A to **30**C for viewing a wide-view image are placed at the sites A to C, respectively. Any communication terminal or communication terminals among the communication terminals **30**A to **30**C are hereinafter referred to as a "communication terminal **30**" or "communication terminals **30**".

In the construction site, workers are involved in various constructions at various places. The image capturing apparatus **10** captures an image of the entire construction site to generate a wide-view image in which the entire construction site appears. A user a at the site A, a user b at the site B, and a user c at the site C can check any construction or work of interest to be viewed by the users a to c at the sites A to C by changing a virtual point of view as appropriate. The term "point of view", as used here, refers to the center position or range of a predetermined area to be displayed on a display screen such as a display. The predetermined area is in the entire wide-view image.

In an example, the image capturing apparatus **10** is attached to a tripod **86**. In another example, the image capturing apparatus **10** is attached to an arm **85** through a gimbal **87**. A relay device is installed at the construction site. In FIG. **1**, the communication terminal **30**A also functions as the relay device. The communication terminal **30**A receives a wide-view image from the image capturing apparatus **10** via a wire or wirelessly and transmits the received wide-view image to the information processing system **50**. The communication terminal **30**A may also function as a terminal for viewing the wide-view image. In an example, a camera **9** connected to (or incorporated in) the communication terminal **30**A captures an image having a normal angle of view (or a wide-view image), and the captured image is transmitted to the information processing system **50**. In another example, smart glasses **88** worn by the user a generates an image having a normal angle of view (or a wide-view image) by imaging an object, and the generated image is transmitted to the information processing system **50**. The user a may be a worker. The smart glasses **88** are an information terminal having a display on which information acquired via the Internet is displayed with a field of view maintained. The smart glasses **88** may be placed at any site.

The communication terminal **30**B, such as a personal computer (PC) or a smartphone, is placed at the site B. The communication terminal **30**B is any device that can communicate with the information processing system **50**. Other examples of the communication terminal **30**B include a tablet terminal, a personal digital assistant (PDA), an electronic whiteboard, and a projector. A camera may be incorporated in or connected to the communication terminal **30**B.

The communication terminal **30**C, such as a PC, a smartphone, or virtual reality (VR) goggles **89**, is placed at the site C. In FIG. **1**, a camera **8** is incorporated in or connected to the communication terminal **30**C. The VR goggles **89** are an information terminal for displaying a computer-based artificial world or a spherical image in accordance with the direction of movement of the neck or the body of the user wearing the VR goggles **89**. The VR goggles **89** may be goggles attached to a smartphone for VR application. Examples of such goggles include an external VR scope, which is a VR scope that allows a user to easily enjoy VR by plugging a smartphone into an assembled body with a lens made of plastic or any other suitable material. The camera **8** may be for a wide angle of view or a normal angle of view. The communication terminal **30**C is any device that can communicate with the information processing system **50**. Other examples of the communication terminal **30**C include a tablet terminal, a PDA, an electronic whiteboard, and a projector. The VR goggles **89** may be placed at any site.

In this embodiment, communication between the image capturing apparatus **10** and the communication terminals **30** is managed using a communication group called a virtual room. The image capturing apparatus **10** is associated with the virtual room. Each of the communication terminals **30** (the user who operates each of the communication terminals **30**) enters the virtual room and receives a wide-view image transmitted from the image capturing apparatus **10**. As a result, the user can view the wide-view image. The smart glasses **88** or the VR goggles **89** can also be associated with the virtual room. Like the communication terminals **30**, the cameras **8** and **9** also enter the virtual room.

The users a to c at the sites A to C can each change the point of view for the wide-view image, as desired, using the communication terminals **30**A to **30**C, respectively. Thus, the users a to c viewing the wide-view image in real time are likely to view images with different points of view. It may be difficult for the users a to c to mutually understand each other. In this embodiment, accordingly, information on a virtual point of view set for the communication terminal **30** at any one of the sites is shareable by the communication terminals **30** at the other sites. An overview of the sharing of information will be described. In the following description, in an example, a point of view designated by the user b at the site B is shared by the users a and c at the sites A and C.

(1) The communication terminals **30**A to **30**C share a wide-view image (an example of a first wide-view image) The wide-view image is generated by imaging an object with the image capturing apparatus **10**. In response to the user b making a request to capture a wide-view image while

viewing the wide-view image from any point of view on the communication terminal **30**B, the communication terminal **30**B (an example of a first communication terminal) transmits point-of-view information and the request to the information processing system **50**.

(2) In response to the request, the information processing system **50** designates point-of-view information and transmits an image capturing request to the image capturing apparatus **10** to capture an image (either a still image or a moving image).

(3) The image capturing apparatus **10** captures a wide-view image (an example of a second wide-view image) in response to the image capturing request, and stores the wide-view image (an example of a second wide-view image) and the point-of-view information in association with a uniform resource locator (URL) transmitted from the information processing system **50**. The URL is an example of storage location information and indicates a storage location in a storage **90** in FIG. **1**. The wide-view image stored in the storage **90** can be downloaded and displayed by any communication terminal **30**.

(4) The information processing system **50** transmits the URL to the communication terminal **30**B.

(5) The information processing system **50** further transmits the URL to the communication terminals **30**A and **30**C (examples of a second communication terminal), which are in the same virtual room as that associated with the image capturing apparatus **10** and the communication terminal **30**B, automatically or in response to a request from the user b.

(6) The communication terminals **30**A and **30**C access the URL and receive the point-of-view information and the wide-view image. Each of the communication terminals **30**A and **30**C sets and displays a point of view for the wide-view image, which is identified by the point-of-view information, such that the point of view matches the center of an image field. It should be noted that the point of view is not necessarily made to completely match the center of the image field. In an example, the point of view may be set and displayed so as to be included in a range near the center of the image field.

The same applies when the point of view of the user a at the site A is shared by the users b and c at the sites B and C and when the point of view of the user c at the site C is shared by the users a and b at the sites A and B.

As described above, in a communication system **1***a* according to this embodiment, even after a wide-view image is distributed, point-of-view information is shared without an instruction being given to shift a point of view for a wide-view image generated by capturing an image such that a predetermined area of interest at each site is displayed. This facilitates understanding among users at the respective sites.

In (3), the image capturing apparatus **10** may transmit the wide-view image itself to the information processing system **50**. In (4), the information processing system **50** may transmit the wide-view image to the communication terminals **30**A to **30**C.

In the example illustrated in FIG. **1**, the image capturing apparatus **10** is placed at a construction site. This embodiment is also applicable to VR education, event distribution, remote customer services, telemedicine services, and other suitable situations. In VR education, the image capturing apparatus **10** is placed at a site such as a study room or a laboratory. Students can view a blackboard, an instrument, a sample, an experimental result, or the like from remote sites while changing the points of view as appropriate. In event distribution, the image capturing apparatus **10** is placed in a venue of an event to be held on-site. Event participants such as an audience can view the details in the venue online from remote sites while changing the points of view as appropriate. The details in the venue include images of event performers, event participants, and event presenters, images of objects involved in the event, such as products or exhibits, images of materials involved in the event, and images of the venue. The event may be held indoor or outdoor, and examples of the venue of the event include venues such as sports stadiums, concert halls, and theaters. In remote customer services, for example, in customer services for a travel agency, the image capturing apparatus **10** is placed at each of travel destination sites. A customer can plan their itinerary from a remote site while changing the point of view as appropriate. In telemedicine services, in an example, the image capturing apparatus **10** is placed in a medical setting such as an operating room. Medical people such as doctors, medical students, and persons related to medical instruments can view the performance of a doctor(s) and a nurse(s) during on-site medical treatment, the arrangement of medical instruments, the state of a patient, vitals, and the like from remote sites while changing the points of view as appropriate.

The site at which an image is captured is not limited to any of the sites described above. An image may be captured in any space that a user (or viewer) at a viewing site desires to remotely grasp. Examples of such a space include a school, a factory, a warehouse, a building site, a server room, and a store.

Terminology

The term "tenant" refers to a group of users associated with a unit contract for receiving an image distribution service from a service provider (information processing system in this embodiment). Examples of the tenant include entities that have made the contract, such as a company, an organization, and an individual. Accordingly, a tenant may also be referred to as a user group. In one example, a user belongs to the tenant. In another example, a user may personally subscribe to the service. A user, an image capturing apparatus, a virtual room, and the like are registered in a tenant (user group).

The term "site" refers to a location where activity takes place. In this embodiment, a conference room is used as an example of a site. The conference room is a room to be used mainly for a conference A conference is an event where people gather to discuss something and is also referred to as a meeting, a session, a gathering, an assembly, or the like.

The term "device" refers to an apparatus different from the communication terminal **30** for general purposes such as a PC or a smartphone. In an example, the device is an image capturing apparatus or an apparatus for viewing a wide-view image. In this embodiment, examples of the device include the image capturing apparatus **10**, the smart glasses **88**, and the VR goggles **89**.

The term "point-of-view information" refers to parameter information that specifies which predetermined area in a wide-view image to be displayed on the display screen of the display is to be displayed on the display screen of the display. In this embodiment, in an example, the point-of-view information includes a radius vector, a polar angle, and an azimuth angle of the center of the wide-view image to be displayed on the display screen of the display. In another example, the point-of-view information may be specified by other parameter information such as the coordinates of diagonal vertices.

The term "wide-view image" refers to an image having a viewing angle in a wider range than a display range that can be displayed on the display screen (area where the wide-view image is to be displayed) of the display at a time in a predetermined display method. The wide-view image has a display range corresponding to a field of view up to 360 degrees (or 180 degrees) in the vertical direction and a field of view up to 360 degrees in the horizontal direction. In an example, the wide-view image is an image having a display range corresponding to a field of view of less than 360 degrees in the vertical and horizontal directions as long as the wide-view image has a viewing angle in a wider range than the display range that can be displayed on the display screen of the display at a time. In another example, the wide-view image is an image having a display range corresponding to a field of view of 160 degrees or more in the vertical and horizontal directions. Examples of the wide-view image include an image having a display range wider than a range that can be visually recognized at a time by a person looking at the range. Depending on the display method, an image that can be displayed on the display screen of the display at a time is also the wide-view image as long as the image has a viewing angle in a wide range in response to the display method being switched to a predetermined display method (such as a display mode or enlargement or reduction) or changed. In this embodiment, a spherical image in equirectangular projection format is used as an example of a wide-view image. Other examples of the wide-view image include an omnidirectional image, a hemispherical image, a three-dimensional (3D) panoramic image, a two-dimensional (2D) panoramic image, and a VR image. The wide-view image may be in cube mapping format or dome master format. The spherical image may be in format other than equirectangular projection format.

An image captured at a normal angle of view is not a wide-view image. In this embodiment, such an image is referred to as a non-wide-view image, that is, a planar image.

The term "communication group" refers to a group of users who share a wide-view image, that is, a group of users to whom a wide-view image is to be distributed. The communication group will be described with the term "virtual room" in the sense that in a typical space, the users in the same room can share a wide-view image. As used herein, the term "virtual" means being implemented by information processing via a network.

Users at respective sites perform remote communication across remote locations. The remote communication is a meeting, which is an online meeting, accessible from remote locations, or sites. The meeting means a gathering of people for consultation, discussion, or the like Examples of the meeting include, but not limited to, serving a customer, a meeting, a conference, a gathering, an assembly, a study session, a class, a seminar, and a presentation. The remote communication is not necessarily bidirectional communication. Thus, the virtual room may be referred to as a virtual conference room.

Example Configuration of Communication System

FIG. **2** is a diagram illustrating an example schematic configuration of the communication system **1***a*. In FIG. **1**, in an example, the communication system **1***a* illustrated in FIG. **2** is applied to remote communication with a construction site. The communication system **1***a* is a system for transmitting and receiving a wide-view image captured by the image capturing apparatus **10** or an image having a normal angle of view bidirectionally among a plurality of sites. In the communication system **1***a*, an image distributed from one of the sites is displayed at the other sites and is viewable to users at the other sites. In an example, a spherical image captured by the image capturing apparatus **10** is distributed as the wide-view image. In the communication system **1***a*, for example, a wide-view image captured at a predetermined site is remotely viewable at another site.

In the communication system **1***a*, as illustrated in FIG. **2**, the image capturing apparatus **10** and the communication terminal **30**A placed at the site A, the information processing system **50**, and the communication terminals **30**B and **30**C placed at a plurality of sites, namely, the sites B and C, respectively, are communicably connected to each other.

In a case where the image capturing apparatus **10** has a communication function capable of directly connecting to a communication network N, the communication terminal **30**A serving as a relay device (e.g., a router) is not used. In this case, the image capturing apparatus **10** is connected to the communication network N without intervention of the communication terminal **30**A. In a case where the communication terminal **30**A is placed at the site A, the communication terminal **30**A also functions as a relay device, and the user a can view a wide-view image in a manner similar to that of the communication terminals **30**B and **30**C. The image capturing apparatus **10** may additionally be placed at a site other than the site A, or a plurality of image capturing apparatuses **10** may be placed at the site A.

Each communication terminal **30** and the information processing system **50** can communicate with each other via the communication network N. The communication network N includes the Internet, a mobile communication network, and a local area network (LAN), for example. The communication network N may include a wired communication network and a wireless communication network. The wireless communication network may be based on a wireless communication standard such as third generation (3G), fourth generation (4G), fifth generation (5G), Wireless Fidelity (Wi-Fi®). Worldwide Interoperability for Microwave Access (WiMAX), or Long Term Evolution (LTE).

In an example, the image capturing apparatus **10** will be described as a digital camera that can capture an image of an object or surroundings such as scenery to obtain two hemispherical images, from which a spherical image is generated, as described below. The digital camera is an example of an image capturing apparatus that can capture a wide-view image. The wide-view image obtained by the image capturing apparatus **10** may be a moving image or a still image, or may include both of a moving image and a still image. Further, the captured image may be video including audio together with an image.

The communication terminal **30** is a computer such as a PC to be operated by a user at each site. The communication terminal **30** displays an image obtained by imaging an object at the site where the communication terminal **30** is placed, and a wide-view image (still image and/or moving image) and an image having a normal angle of view, which are distributed from other sites. For example, the communication terminal **30** acquires a wide-view image, which is captured by the image capturing apparatus **10**, via the communication network N. The communication terminal **30** has installed therein software for executing image processing, such as Open Graphics Library for Embedded Systems (OpenGL ES), and can display an image based on point-of-view information that specifies a partial area in the wide-view image. OpenGL ES is an example of software for executing image processing. Any other software may be used. In an example, the communication terminal **30** does not have installed therein software for executing image

processing, and executes image processing by using software received from the outside or receives a result of image processing executed by external software to display an image. That is, the communication terminal **30** can display a predetermined area, which is part of the wide-view image.

The communication terminal **30** can change the point of view for the display range of the wide-view image, as desired, in response to the user's operation. The communication terminal **30** shifts the virtual point of view in response to a user operation input (such as key input, dragging, or scrolling) on a touch panel, a direction button, a mouse, a keyboard, a touch pad, or the like to change and display a visual field range (predetermined area) based on point-of-view information corresponding to a point of view obtained by shifting the virtual point of view. In an example, the communication terminal **30** is a communication terminal to be worn by the user, such as VR goggles. In response to a change in the movement of the user wearing the communication terminal **30**, position information of the communication terminal **30** is changed. In response to detection of the change in the position information, the virtual point of view is shifted in accordance with the detected position information to change a visual field range (predetermined area), based on point-of-view information corresponding to a point of view obtained by shifting the virtual point of view, and the changed visual field range (predetermined area) is displayed.

The communication terminal **30**A acquires a wide-view image from the image capturing apparatus **10** via a wired cable such as a Universal Serial Bus (USB) cable connected to an input/output interface (I/F) **116** described below. The communication terminal **30**A distributes the acquired wide-view image to the communication terminal **30** at another site via the information processing system **50**. The connection between the image capturing apparatus **10** and the communication terminal **30**A may be either a wired connection using a wired cable or a wireless connection using short-range wireless communication, for example. A plurality of communication terminals **30**A may be placed at the site A.

In an example, the user a at the site A wears the smart glasses **88**, and the smart glasses **88** are connected to the communication network N. An image captured by the smart glasses **88** is transmitted to the information processing system **50** via the communication network N, and the information processing system **50** can distribute the image to the communication terminal **30** at each site.

The communication terminal **30**B is placed at the site B where the user b is located, and the communication terminal **30**C is placed at the site C where the user c is located. A plurality of communication terminals **30**B may be placed at the site B, and a plurality of communication terminals **30**C may be placed at the site C. The users b and c may carry the communication terminals **30**B and **30**C, respectively.

Each of the communication terminals **30**A to **30**C at the sites A to C can be internally or externally provided with the camera **8** or **9**. The cameras **8** and **9** are examples of an imaging device. Each of the communication terminals **30**A to **30**C can distribute an image of the corresponding one of the sites A to C, which is captured by the camera **8** or **9** thereof, to the other sites. Any device may be placed at each of the sites A to C.

The arrangement of the terminals and apparatus (i.e., the communication terminals **30** and the image capturing apparatus **10**) and the users a to c illustrated in FIG. **2** is an example. Any other arrangement may be used. The communication terminal **30** is not limited to a PC and may be, for example, a tablet terminal, a smartphone, a PDA, a wearable terminal (including smart glasses or VR goggles), a projector (PJ), an Interactive White Board (IWB), which is an electronic whiteboard with mutual communication capability, a telepresence robot, or the like. The communication terminal **30** is any computer on which a web browser or an application dedicated to an image distribution service operates.

In an example, the image capturing apparatus **10** includes a display and displays an image distributed from another site on the display.

The information processing system **50** includes one or more information processing apparatuses. The information processing system **50** manages and controls communication among the image capturing apparatus **10** and the communication terminals **30** at the respective sites and manages a wide-view image to be transmitted and received. The information processing system **50** provides a platform on which a function of providing an image distribution service for distributing a wide-view image is available. The platform may be made available to a person, a company, or any other service provider that desires to provide an image distribution service, under contract. A service provider that provides an image distribution service to a user by using a contracted platform is hereinafter referred to as a platform contractor to distinguish the service provider from a tenant who receives the image distribution service.

The information processing system **50** may publish an application programming interface (API) as a platform, and the platform contractor may use the API to provide various image distribution services. The platform contractor mainly develops software such as an application for calling the API or the screen to be displayed on the communication terminal **30**. That is, the functions to be provided by the API, such as image distribution, do not have to be developed from scratch.

The information processing system **50** may be implemented by a single computer or a plurality of computers such that the components (functions or means) of the information processing system **50** are divided into and assigned to the plurality of computers as appropriate. All or some of the functions of the information processing system **50** may be implemented by a server computer residing in a cloud environment or a server computer residing in an on-premise environment.

The storage **90** is a storage device that stores data of a wide-view image and the like. In an example, the storage **90** is an external storage separate from the information processing system **50**. The external storage may be a cloud or on-premise storage. In another example, the storage **90** is a storage included in the information processing system **50**.

Example Hardware Configurations

Next, the hardware configurations of each apparatus or terminal included in the communication system **1***a* according to this embodiment will be described with reference to FIGS. **3** and **4**. In the hardware configurations illustrated in FIGS. **3** and **4**, certain hardware elements may be added or deleted as appropriate.

Hardware Configuration of Image Capturing Apparatus

First, the hardware configuration of the image capturing apparatus **10** will be described with reference to FIG. **3**. FIG. **3** is a diagram illustrating an example hardware configuration of the image capturing apparatus **10**. In the following description, the image capturing apparatus **10** is a spherical (omnidirectional) image capturing apparatus including two imaging elements. However, the image capturing apparatus **10** may include one imaging element or three or more imaging elements. In one example, the image capturing apparatus **10** is not dedicated to omnidirectional image

capturing, and an external omnidirectional image capturing unit is attached to a general-purpose digital camera or a smartphone to implement functions that are substantially the same as those of the image capturing apparatus **10**.

As illustrated in FIG. **3**, the image capturing apparatus **10** includes an imaging unit **101**, an image processor **104**, an imaging controller **105**, a microphone **108**, an audio processor **109**, a central processing unit (CPU) **111**, a read only memory (ROM) **112**, a static random access memory (SRAM) **113**, a dynamic random access memory (DRAM) **114**, an operation unit **115**, an input/output interface (I/F) **116**, a short-range communication circuit **117**, an antenna **117***a* for the short-range communication circuit **117**, an electronic compass **118**, a gyro sensor **119**, an acceleration sensor **120**, and a network I/F **121**.

The imaging unit **101** includes two wide-angle lenses (so-called fish-eye lenses) **102***a* and **102***b* (collectively referred to as lens **102** unless distinguished), each having an angle of view of equal to or greater than 180 degrees so as to form a hemispherical image. The imaging unit **101** further includes two imaging elements **103***a* and **103***b* corresponding to the lenses **102***a* and **102***b* respectively. Each of the imaging elements **103***a* and **103***b* includes an image sensor such as a complementary metal oxide semiconductor (CMOS) sensor or a charge-coupled device (CCD) sensor, a timing generation circuit, and a group of registers. The image sensor converts an optical image formed by the lens **102***a* or **102***b* into an electric signal and outputs image data. The timing generation circuit generates horizontal or vertical synchronization signals, pixel clocks, and the like for the image sensor. In the group of registers, various commands, parameters, and the like for an operation of the imaging element **103***a* or **103***b* are set. As a non-limiting example, the imaging unit **101** includes two wide-angle lenses. The imaging unit **101** may include one wide-angle lens or three or more wide-angle lenses.

Each of the imaging elements **103***a* and **103***b* of the imaging unit **101** is connected to the image processor **104** via a parallel I/F bus. Further, each of the imaging elements **103***a* and **103***b* of the imaging unit **101** is connected to the imaging controller **105** via a serial I/F bus such as an inter-integrated circuit (I2C) bus. The image processor **104**, the imaging controller **105**, and the audio processor **109** are connected to the CPU **111** via a bus **110**. The ROM **112**, the SRAM **113**, the DRAM **114**, the operation unit **115**, the input/output I/F **116**, the short-range communication circuit **117**, the electronic compass **118**, the gyro sensor **119**, the acceleration sensor **120**, and the network I/F **121** are also connected to the bus **110**.

The image processor **104** acquires respective items of image data output from the imaging elements **103***a* and **103***b* via the parallel I/F buses and performs predetermined processing on the items of image data. Thereafter, the image processor **104** combines the items of image data to generate data of an equirectangular projection image (an example of a wide-view image) described below.

The imaging controller **105** usually functions as a master device while each of the imaging elements **103***a* and **103***b* usually functions as a slave device. The imaging controller **105** sets commands and the like in the group of registers of each of the imaging elements **103***a* and **103***b* via the I2C bus. The imaging controller **105** receives various commands from the CPU **111**. The imaging controller **105** further acquires status data and the like of the group of registers of each of the imaging elements **103***a* and **103***b* via the I2C bus. The imaging controller **105** sends the obtained status data and the like to the CPU **111**.

The imaging controller **105** instructs the imaging elements **103***a* and **103***b* to output the image data at the time when a shutter button of the operation unit **115** is pressed. In one example, the image capturing apparatus **10** displays a preview image or a moving image (movie) on a display. Examples of the display include a display of a smartphone or any other external terminal that performs short-range communication with the image capturing apparatus **10** through the short-range communication circuit **117**. In the case of displaying movie, image data are continuously output from the imaging elements **103***a* and **103***b* at a predetermined frame rate (expressed in frames per minute).

As described below, the imaging controller **105** operates in cooperation with the CPU **111** to synchronize the time when the imaging element **103***a* outputs image data and the time when the imaging element **103***b* outputs the image data. In this embodiment, the image capturing apparatus **10** does not include a display unit (or display). In some embodiments, the image capturing apparatus **10** may include a display unit. The microphone **108** converts sound to audio data (signal). The audio processor **109** acquires the audio data output from the microphone **108** via an I/F bus and performs predetermined processing on the audio data.

The CPU **111** controls entire operation of the image capturing apparatus **10** and performs predetermined processing. The ROM **112** stores various programs for execution by the CPU **111**. Each of the SRAM **113** and the DRAM **114** operates as a work memory to store programs to be executed by the CPU **111** and data being currently processed. More specifically, in one example, the DRAM **114** stores image data currently processed by the image processor **104** or data of the equirectangular projection image on which processing has been performed.

The operation unit **115** collectively refers to various operation buttons such as a shutter button, a power switch, a touch panel having both the display and operation functions, and the like. The user operates the operation unit **115** to input various image capturing modes or image capturing conditions.

The input/output I/F **116** collectively refers to an interface circuit such as a USB I/F that allows the image capturing apparatus **10** to communicate with an external medium such as a Secure Digital (SD) card or an external personal computer. The input/output I/F **116** may be either wired or wireless. The data of the equirectangular projection image, which is stored in the DRAM **114**, is stored in the external medium via the input/output I/F **116** or transmitted to an external terminal (apparatus) via the input/output I/F **116**, as desired.

The short-range communication circuit **117** communicates with the external terminal (apparatus) via the antenna **117***a* of the image capturing apparatus **10** by short-range wireless communication technology such as near field communication (NFC), Bluetooth®, or Wi-Fi®. The short-range communication circuit **117** can transmit the data of the equirectangular projection image to the external terminal (apparatus).

The electronic compass **118** calculates an orientation of the image capturing apparatus **10** from the Earth's magnetism and outputs orientation information. The orientation information is an example of related information (metadata) in compliance with exchangeable image file format (Exif). The orientation information is used for image processing such as image correction of a captured image. The related information also includes data of a date and time when the image was captured, and data of a data size of image data.

The gyro sensor **119** detects a change in tilt (roll, pitch, and yaw) of the image capturing apparatus **10** with movement of the image capturing apparatus **10**. The change in tilt is one example of related information (metadata) in compliance with Exif. This information is used for image processing such as image correction of a captured image.

The acceleration sensor **120** detects acceleration in three axial directions. The image capturing apparatus **10** calculates the position of the image capturing apparatus **10** (e.g., the tilt of the image capturing apparatus **10** relative to the direction of gravity), based on the acceleration detected by the acceleration sensor **120**. The acceleration sensor **120** of the image capturing apparatus **10** improves the accuracy of image correction.

The network I/F **121** is an interface for performing data communication using the communication network N, such as the Internet, via a router or the like. The hardware elements of the image capturing apparatus **10** are not limited to the illustrated ones as long as the functional configuration of the image capturing apparatus **10** can be implemented. At least some of the hardware elements described above may reside on the communication network N.

Hardware Configuration of Communication Terminal

FIG. **4** is a diagram illustrating an example hardware configuration of the communication terminal **30** and the information processing system **50**. First, the communication terminal **30** will be described. Each hardware element of the communication terminal **30** is denoted by a reference numeral in **300** series. The communication terminal **30** is implemented by one or more computers. As illustrated in FIG. **4**, the communication terminal **30** includes a CPU **301**, a ROM **302**, a RAM **303**, a hard disk drive (HDD) **304**, an HDD controller **305**, a display **306**, an external device connection I/F **308**, a network I/F **309**, a bus line **310**, a keyboard **311**, a pointing device **312**, a digital versatile disc rewritable (DVD-RW) drive **314**, a media I/F **316**, an audio input/output I/F **317**, a microphone **318**, a speaker **319**, a short-range communication circuit **320**, and a camera **321**.

The CPU **301** controls entire operation of the communication terminal **30**. The ROM **302** stores a control program such as an initial program loader (IPL) for booting the CPU **301**. The RAM **303** is used as a work area for the CPU **301**. The HDD **304** stores a program and various data. The HDD controller **305** controls reading or writing of various data from or to the HDD **304** under control of the CPU **301**.

The display **306** displays various kinds of information such as a cursor, a menu, a window, characters, and an image. In one example, the display **306** is a touch panel display provided with an input means. The display **306** is an example of a display unit. Examples of the display unit include a display of the communication terminal **30**, an external display attached to the communication terminal **30**, a display of another communication terminal different from the communication terminal **30**, and a screen (including an object to be displayed using projection mapping) projected by a projector.

The external device connection I/F **308** is an interface for connecting to various external devices. The external devices include, but are not limited to, a USB memory and a printer. The network I/F **309** is an interface for performing data communication using the communication network N. The bus line **310** is an address bus or a data bus for electrically connecting the hardware elements illustrated in FIG. **4**, such as the CPU **301**, to each other. The HDD **304** and the HDD controller **305** are each an example of a storage that stores a program, data, and the like, and may be a solid state drive (SSD) or an SSD controller, respectively.

The keyboard **311** is an example of an input means including a plurality of keys for inputting characters, numerical values, various instructions, and the like. The pointing device **312** is an example of an input means used for selecting or executing various instructions, selecting a target for processing, or moving a cursor being displayed. The input means are not limited to the keyboard **311** and the pointing device **312** and may be a touch panel, a voice input device, or the like. The DVD-RW drive **314** controls reading or writing of various data from or to a DVD-RW **313**, which is an example of a removable recording medium. A DVD-R, a Blu-ray Disc®, or any other recording medium may be used instead of the DVD-RW **313**. The media I/F **316** controls reading or writing (storing) of data from or to a recording medium **315** such as a flash memory. The microphone **318** is an example of a built-in sound collecting means for receiving input sounds. The audio input/output I/F **317** is a circuit for controlling input and output of audio signals between the microphone **318** and the speaker **319** under control of the CPU **301**. The short-range communication circuit **320** communicates with the external terminal (apparatus) by short-range wireless communication technology such as NFC, Bluetooth®, or Wi-Fi®. The camera **321** is an example of a built-in image capturing means for capturing an image of an object to obtain image data. In one example, the microphone **318**, the speaker **319**, and the camera **321** are devices external to the communication terminal **30** in alternative to built-in devices.

The hardware elements of the communication terminal **30** are not limited to the illustrated ones as long as the functional configuration of the communication terminal **30** can be implemented. At least some of the hardware elements described above may reside on the communication network N.

Hardware Configuration of Information Processing System

As illustrated in FIG. **4**, each hardware element of the information processing system **50** is denoted by a reference numeral in **500** series in parentheses. The information processing system **50** is implemented by one or more computers and has substantially the same configuration as that of the communication terminal **30** illustrated in FIG. **4**, and thus the description of the hardware configuration of the information processing system **50** will be omitted.

The hardware elements of the information processing system **50** are not limited to the illustrated ones as long as the functional configuration of the information processing system **50** can be implemented. At least some of the hardware elements described above may reside on a network.

Each of the programs described above (including a viewer application) may be recorded as a file in a format installable or executable on a (non-transitory) computer-readable recording medium for distribution. Examples of the recording medium include a compact disc recordable (CD-R), a digital versatile disc (DVD), a Blu-ray Disc™, an SD card, and a USB memory. The recording medium may be provided in the form of a program product to users within a certain country or outside that country. For example, in the communication terminal **30**, a program according to an embodiment of the present disclosure is executed to implement an image display method according to an embodiment of the present disclosure.

Wide-View Image and Point-of-View Information

A method for generating a wide-view image (spherical image) will be described hereinafter with reference to FIGS. **5**A to **12**.

First, the external appearance of the image capturing apparatus **10** will be described with reference to FIGS. **5**A

to **5**C. The image capturing apparatus **10** is a digital camera for capturing images from which a 360-degree spherical image is generated. FIG. **5**A is a left side view of the image capturing apparatus **10**. FIG. **5**B is a front view of the image capturing apparatus **10**. FIG. **5**C is a plan view of the image capturing apparatus **10**. The illustrated external view of the image capturing apparatus **10** is merely an example. The image capturing apparatus **10** may have any other external appearance.

As illustrated in FIG. **5**A, the image capturing apparatus **10** has a size such that a person can hold the image capturing apparatus **10** with one hand. The illustrated shape of the image capturing apparatus **10** is an example. The image capturing apparatus **10** may have any other shape. As illustrated in FIGS. **5**A, **5**B, and **5**C, the imaging element **103***a* and the imaging element **103***b* are disposed in an upper portion of the image capturing apparatus **10** such that the imaging element **103***a* is disposed on the front side and the imaging element **103***b* is disposed on the back side. The imaging elements (image sensors) **103***a* and **103***b* are used in combination with optical members (e.g., the lenses **102***a* and **102***b* described above), each being configured to capture a hemispherical image having an angle of view of equal to or greater than 180 degrees. As illustrated in FIG. **5**B, the operation unit **115**, such as a shutter button, is disposed on the back surface of the image capturing apparatus **10**. As described above, the image capturing apparatus **10** may include one imaging element or three or more imaging elements.

Next, a situation where the image capturing apparatus **10** is used will be described with reference to FIG. **6**. FIG. **6** is an illustration for explaining how a user uses the image capturing apparatus **10**. As illustrated in FIG. **6**, for example, the image capturing apparatus **10** is used for capturing an image of objects surrounding the image capturing apparatus **10**. Each of the imaging elements **103***a* and **103***b* illustrated in FIGS. **5**A to **5**C captures an image of the objects surrounding the image capturing apparatus **10**. As a result, two hemispherical images are obtained.

Next, an overview of a process for generating a spherical image from the images captured by the image capturing apparatus **10** will be described with reference to FIGS. **7**A to **7**C and FIGS. **8**A and **8**B. FIG. **7**A is a view illustrating a hemispherical image (front side) captured by the image capturing apparatus **10**. FIG. **7**B is a view illustrating a hemispherical image (back side) captured by the image capturing apparatus **10**. FIG. **7**C is a view illustrating an image in equirectangular projection (hereinafter referred to as an "equirectangular projection image" or an "equidistant cylindrical projection image"). FIG. **8**A is a conceptual diagram illustrating how the equirectangular projection image is mapped to a surface of a sphere. FIG. **8**B is a view illustrating a spherical image. The term "equirectangular projection image" refers to a spherical image in equirectangular projection format, which is an example of the wide-view image described above.

As illustrated in FIG. **7**A, an image obtained by the imaging element **103***a* is a curved hemispherical image (front side) captured through the lens **102***a* described above. As illustrated in FIG. **7**B, an image captured by the imaging element **103***b* is a curved hemispherical image (back side) captured through the lens **102***b* described above. The image capturing apparatus **10** combines the hemispherical image (front side) and the hemispherical image (back side), which are flipped by 180 degrees, to create an equirectangular projection image EC as illustrated in FIG. **7**C.

The image capturing apparatus **10** uses software such as OpenGL ES to map the equirectangular projection image EC so as to cover a surface of a sphere as illustrated in FIG. **8**A, to generate a spherical image (or spherical panoramic image) CE as illustrated in FIG. **8**B. That is, the spherical image CE is represented as the equirectangular projection image EC, which corresponds to a surface facing the center of the sphere. OpenGL ES is a graphics library used for visualizing 2D and 3D data. OpenGL ES is an example of software for executing image processing. Any other software may be used to create the spherical image CE. The spherical image CE may be either a still image or a moving image. As a non-limiting example, the image capturing apparatus **10** generates a spherical image. In another example, the information processing system **50** or the communication terminal **30** executes similar image processing or some steps of the image processing.

Since the spherical image CE is an image mapped so as to cover the surface of the sphere, part of the image may look distorted when viewed by a user, providing a strange feeling. To overcome the strange feeling, the image capturing apparatus **10** or the communication terminal **30** displays an image of a predetermined area T, which is part of the spherical image CE, as a planar image having fewer curves to make the user feel comfortable when viewing the image. The image of the predetermined area T is referred to as a "predetermined-area image". The display of the predetermined-area image will be described with reference to FIGS. **9** and **10**A to **10**D.

FIG. **9** is a view illustrating the position of a virtual camera IC and the position of the predetermined area T in a case where the spherical image CE is of a three-dimensional sphere CS. The position of the virtual camera IC corresponds to the position of a virtual point of view of a user who is viewing the spherical image CE represented as a surface area of the three-dimensional sphere CS. FIG. **10**A is a perspective view of the virtual camera IC and the predetermined area T illustrated in FIG. **9**. FIG. **10**B is a view illustrating a predetermined-area image obtained in the state illustrated in FIG. **10**A and displayed on a display. FIG. **10**C is a view of a predetermined area obtained by changing the point of view of the virtual camera IC illustrated in FIG. **10**A. FIG. **10**D is a view illustrating a predetermined-area image obtained in the state illustrated in FIG. **10**C and displayed on the display.

Assuming that the spherical image CE generated in the way described above is a surface area of the sphere CS, the virtual camera IC is inside the spherical image CE as illustrated in FIG. **9**. The predetermined area T in the spherical image CE is an imaging area of the virtual camera IC. Specifically, the predetermined area T is specified by predetermined-area information indicating an imaging direction and an angle of view of the virtual camera IC in a three-dimensional virtual space containing the spherical image CE. Zooming in or out of the predetermined area T can be implemented by bringing the virtual camera IC closer to or farther away from the spherical image CE. A predetermined-area image Q is the image of the predetermined area T in the spherical image CE. The predetermined area T is defined by an angle of view α of the virtual camera IC and a distance f from the virtual camera IC to the spherical image CE (see FIG. **11**).

The predetermined-area image Q illustrated in FIG. **10**A is displayed on a predetermined display as an image of the imaging area of the virtual camera IC, as illustrated in FIG. **10**B. The image illustrated in FIG. **10**B is a predetermined-area image represented by predetermined-area information

that is set by default. A description will be made using the imaging direction (ea, aa) and the angle of view (a) of the virtual camera IC In another example, the predetermined area T is not defined by the angle of view α and the distance f, and the imaging area of the virtual camera IC, which is the predetermined area T, is identified by position coordinates (X, Y, Z).

As illustrated in FIG. **10**C, in response to the shift (also referred to as "change") of the point of view of the virtual camera IC to the right (i.e., to the left from the viewer's perspective) from the state illustrated in FIG. **10**A, the predetermined area T in the spherical image CE is shifted to a predetermined area T'. Accordingly, the predetermined-area image Q displayed on the predetermined display is changed to a predetermined-area image Q'. As a result, the image illustrated in FIG. **10**B is changed to the image illustrated in FIG. **10**D, and the image illustrated in FIG. **10**D is displayed on the display.

Next, a relationship between the predetermined-area information and the image of the predetermined area T will be described with reference to FIG. **11**. FIG. **11** is a view illustrating a relationship between the predetermined-area information and the image of the predetermined area T. As illustrated in FIG. **11**, "ea" denotes an elevation angle, "aa" denotes an azimuth angle, and "α" denotes an angle of view of the virtual camera IC. The position of the virtual camera IC is adjusted such that the point of gaze of the virtual camera IC, indicated by the imaging direction (ea, aa), matches a center point CP (x, y) of the predetermined area T serving as the imaging area of the virtual camera IC. As illustrated in FIG. **11**, the center point CP (x, y) of the predetermined area T, whose diagonal angle of view is represented by the angle of view α of the virtual camera IC and is denoted by a, is used as a parameter (x, y) of the predetermined-area information. The predetermined-area image Q is the image of the predetermined area T in the spherical image CE. The distance f is a distance from the virtual camera IC to the center point CP (x, y) of the predetermined area T. The distance between the center point CP (x, y) and a given vertex of the predetermined area T is denoted by "L" (**2**L is a diagonal line). In FIG. **11**, a trigonometric function generally expressed by Equation (1) below holds.

$$(L/f)=\tan(\alpha/2) \quad \text{Equation (1)}$$

The image capturing apparatus **10** described above is an example of an image capturing apparatus that can acquire a wide-view image. The spherical image CE is an example of a wide-view image. The wide-view image is generally an image taken with a wide-angle lens such as a lens that can take an image of a range wider than a range that the human eye can perceive.

FIG. **12** is a view illustrating the relationship illustrated in FIG. **11** using a point in a three-dimensional Euclidean space defined in spherical coordinates. The center point CP illustrated in FIG. **11** is represented by a spherical polar coordinate system to obtain position coordinates (r, θ, φ). The position coordinates (r, θ, φ) represent a radius vector, a polar angle, and an azimuth angle, respectively. The radius vector r is a distance from the origin of the three-dimensional virtual space including the spherical image CE to the center point CP. Accordingly, the radius vector r is equal to the distance f illustrated in FIG. **11**. FIG. **12** illustrates the relationship illustrated in FIG. **11**. In the following description, the position coordinates (r, θ, φ) of the virtual camera IC are used as an example of point-of-view information. As described above, the point-of-view information is any parameter information that can define the predetermined area T (the predetermined-area image Q) displayed on the predetermined display illustrated in FIG. **10**A as the image of the imaging area of the virtual camera IC. The point-of-view information includes the coordinates of the diagonal vertices of the predetermined area T. In an example, the point-of-view information includes information indicating the angle of view α of the virtual camera IC and information indicating the center point CP (x, y), which have been described with reference to FIG. **11**. In another example, the point-of-view information includes information indicating the angle of view α of the virtual camera IC and information indicating the azimuth angle aa, which have been described with reference to FIG. **11**. Examples of the point-of-view information include position coordinate information in the form of spherical coordinates, position coordinate information in the form of orthogonal coordinates, and a difference value between the predetermined-area information that is set by default and the coordinates. Other examples of the point-of-view information include information other than coordinate information, such as an angle and a distance, as illustrated in FIG. **11**. In FIGS. **11** and **12**, the center point CP of the predetermined area Tis used as a reference. In another example, the predetermined area T may be defined by parameter information with any one of the vertices of the predetermined area T as a reference. In the foregoing description of the point-of-view information, as a non-limiting example, the wide-view image is a spherical image. In any other wide-view image, information that defines the predetermined area T in the other wide-view image is point-of-view information.

The point-of-view information may include parameter information such as the height and width of the predetermined area T or parameter information such as the magnification factor of the virtual camera IC by zooming in or out. In an example, the point-of-view information is parameter information such as the direction and the angle of view of the virtual camera IC in a case where the position of each pixel in the equirectangular projection image EC illustrated in FIG. **7**C is associated with the coordinates of the corresponding position on the surface of the sphere (e.g., coordinates on two axes, namely, latitude and longitude). In another example, the point-of-view information includes information such as latitude and longitude. As described above, the point-of-view information is not limited to information indicating a point.

Functions

Next, the functional configuration of the communication system **1***a* according to this embodiment will be described with reference to FIG. **13**. FIG. **13** is a diagram illustrating an example functional configuration of the communication system **1***a* according to this embodiment. FIG. **13** illustrates functions, related to processes or operations described below, of the terminals, the apparatus, and the server illustrated in FIG. **1**.

Functional Configuration of Image Capturing Apparatus

First, the functional configuration of the image capturing apparatus **10** will be described with reference to FIG. **13**. The image capturing apparatus **10** includes a communication unit **11**, an acceptance unit **12**, an imaging processing unit **13**, an analysis unit **14**, a registration request unit **15**, a connection unit **16**, a storage processing unit **17**, an image transmission control unit **18**, and a storing/reading unit **19**. Each of these units is a function or means that is implemented by any one of the hardware elements illustrated in FIG. **3** operating in accordance with instructions from the CPU **111** according to the program loaded onto the SRAM

113 or the DRAM 114. The image capturing apparatus 10 further includes a storage unit 1000, which is implemented by the ROM 112 and the like illustrated in FIG. 3.

The communication unit 11 is mainly implemented by the short-range communication circuit 117 operating in accordance with instructions from the CPU 111. The communication unit 11 is a function of connecting to the communication network N by using wireless communication technology such as Wi-Fi® to transmit and receive various data or information to and from another apparatus. In this embodiment, the connection unit 16 transmits a wide-view image acquired by the imaging processing unit 13 to the information processing system 50. In some embodiments, the communication unit 11 may transmit the wide-view image to the information processing system 50.

The acceptance unit 12 is mainly implemented by the operation unit 115 operating in accordance with instructions from the CPU 111. The acceptance unit 12 is a function of accepting an operation input to the image capturing apparatus 10 from the user. The acceptance unit 12 accepts the operation of turning on or off the power, turning on or off the shutter button (start or stop of transmission of the wide-view image), an operation input to a touch panel, a button, or the like from the user.

The imaging processing unit 13 is mainly implemented by the image processor 104 operating in accordance with instructions from the CPU 111. The imaging processing unit 13 captures an image of an object or surroundings such as scenery and acquires (generates) a captured image. The captured image acquired by the imaging processing unit 13 may be either or both of a moving image and a still image. In another example, the captured image may include an image and audio. Further, for example, the imaging processing unit 13 captures an image of a two-dimensional code (see FIG. 20B) displayed on the display 306 of the communication terminal 30. The imaging processing unit 13 may execute the image processing described with reference to FIGS. 7A to 8B on the captured image to generate a wide-view image.

The analysis unit 14 is mainly implemented in accordance with instructions from the CPU 111. The analysis unit 14 analyzes the two-dimensional code, of which the image is captured by the imaging processing unit 13, to extract information included in the two-dimensional code. The extracted information includes a URL for registering the image capturing apparatus 10 in the tenant, a temporary ID, and a password.

The registration request unit 15 is mainly implemented in accordance with instructions from the CPU 111. The registration request unit 15 transmits a request to the information processing system 50 via the communication unit 11 to register the image capturing apparatus 10 in the tenant in the information processing system 50, by using the information included in the two-dimensional code read by the analysis unit 14.

The connection unit 16 is mainly implemented by the input/output I/F 116 operating in accordance with instructions from the CPU 111. The connection unit 16 is a function of receiving a supply of power from the communication terminal 30A and performing data communication.

The storage processing unit 17 is mainly implemented in accordance with instructions from the CPU 111. The storage processing unit 17 performs a process of storing a wide-view image captured in response to an image capturing request from any site in a URL (e.g., a URL that specifies the storage 90) transmitted from the information processing system 50.

The image transmission control unit 18 is mainly implemented in accordance with instructions from the CPU 111. The image transmission control unit 18 is a function of controlling transmission of the wide-view image to the information processing system 50. For example, the image transmission control unit 18 transmits a captured image acquired by the imaging processing unit 13 to the information processing system 50 periodically or in response to a user operation when the captured image is a still image, or at a predetermined frame rate (expressed in frames per second or FPS) when the captured image is a moving image. The image transmission control unit 18 also performs switching between the communication unit 11 and the connection unit 16.

The storing/reading unit 19 is mainly implemented in accordance with instructions from the CPU 111. The storing/reading unit 19 is a function of storing various data in the storage unit 1000 or reading various data from the storage unit 1000. The storage unit 1000 stores captured image data acquired by the imaging processing unit 13, an image capturing apparatus ID, and the like. The captured image data stored in the storage unit 1000 may be deleted when a predetermined amount of time has elapsed after the captured image data was acquired by the imaging processing unit 13, or the data transmitted to the information processing system 50 may be deleted.

The image capturing apparatus 10 has installed therein an application (also referred to as a plug-in) for supporting the communication system 1*a*. The application is used to associate the image capturing apparatus 10 with the virtual room or to accept external control. Some of the functions illustrated in FIG. 13, such as the registration request unit 15, are implemented by the application. The application for supporting the communication system 1*a* may reside on the communication network N, and a web browser or the like included in the image capturing apparatus 10 may access the application to implement similar functions.

Functional Configuration of Communication Terminal

Next, the functional configuration of the communication terminal 30 will be described with reference to FIG. 13. The communication terminal 30 includes a communication unit 31, an acceptance unit 32, a display control unit 33, an imaging unit 34, a recording unit 35, a storing/reading unit 39, a connection unit 36, and a screen generation unit 37. Each of these units is a function or means that is implemented by any one of the hardware elements illustrated in FIG. 4 operating in accordance with instructions from the CPU 301 according to the program (either the web browser or a dedicated application) loaded onto the RAM 303. The communication terminal 30 further includes a storage unit 3000. The storage unit 3000 is implemented by the ROM 302 or the recording medium 315 illustrated in FIG. 4.

The communication unit 31 is implemented by the network I/F 309 operating in accordance with instructions from the CPU 301. The communication unit 31 is a function of connecting to the communication network N to transmit or receive various data or information to or from another apparatus.

The acceptance unit 32 is mainly implemented by the keyboard 311 and the pointing device 312 operating in accordance with instructions from the CPU 301. The acceptance unit 32 is a function of accepting various selection or operation inputs to the communication terminal 30. The display control unit 33 is a function of displaying a wide-view image, an image having a normal angle of view, and at least one of various screen images on the display 306 of the communication terminal 30. In an example, the communi-

cation terminal **30** may include a touch panel or an interface for gesture or voice input. In this example, the communication terminal **30** may accept various selections or operation inputs in accordance with a touch input, a gesture input, or a voice input.

The display control unit **33** is mainly implemented in accordance with instructions from the CPU **301**. For example, the display control unit **33** causes the display **306** to display a two-dimensional code transmitted from the information processing system **50**. In an example, the two-dimensional code is QR Code®, DataMatrix (DataCode), MaxiCode, or Portable Document Format (PDF). In another example, the two-dimensional code is a barcode.

The imaging unit **34** is implemented by the camera **321** operating in accordance with instructions from the CPU **301**. The imaging unit **34** captures an image of an object and the surroundings of the object.

The recording unit **35** is implemented in accordance with instructions from the CPU **301**. The recording unit **35** records data of a wide-view image related to a moving image distributed from the information processing system **50** after the data of the wide-view image is received by the communication unit **31** to store recorded image data in the storage unit **3000** through the storing/reading unit **39**.

The connection unit **36** is mainly implemented by the short-range communication circuit **320** operating in accordance with instructions from the CPU **301**. The connection unit **36** is a function of supplying power to the image capturing apparatus **10** and performing data communication.

The screen generation unit **37** is implemented by a viewer application in accordance with instructions of the CPU **301**. The screen generation unit **37** generates (or creates) a thumbnail image of a predetermined-area image indicated by each item of point-of-view information. In an example, the viewer application is not installed in advance, and the communication terminal **30** may have a function equivalent to that of the screen generation unit **37** in advance. In another example, the communication terminal **30** may receive a program having a function equivalent to that of a viewer application having the function of the screen generation unit **37** from the information processing system **50** or any other server at the time of entry into the virtual room and implement the function of the screen generation unit **37**. The viewer application of the communication terminal **30** may be implemented by a web browser.

The storing/reading unit **39** is mainly implemented in accordance with instructions from the CPU **301**. The storing/reading unit **39** is a function of storing various data in the storage unit **3000** or reading various data from the storage unit **3000**. The storage unit **3000** includes an image management information storage unit **3001**. The image management information storage unit **3001** will be described in the description of the information processing system **50**.

Functional Configuration of Information Processing System

Next, the functional configuration of the information processing system **50** will be described. The information processing system **50** includes a communication unit **51**, a screen generation unit **52**, an association processing unit **53**, an image distribution unit **54**, an authentication unit **55**, a communication group management unit **56**, a communication control unit **57**, a connection management unit **58**, a storing/reading unit **59**, and an API management unit **60**. Each of these units is a function or means that is implemented by any one of the hardware elements illustrated in FIG. **4** operating in accordance with instructions from the CPU **501** according to the program loaded onto the RAM **503**. The information processing system **50** further includes a storage unit **5000**. The storage unit **5000** is implemented by the ROM **502**, the HDD **504**, or the recording medium **515** illustrated in FIG. **4**.

The communication unit **51** is mainly implemented by the network I/F **509** operating in accordance with instructions from the CPU **501**. The communication unit **51** is a function of transmitting or receiving various data or information to or from another apparatus via the communication network N.

The screen generation unit **52** is mainly implemented in accordance with instructions from the CPU **501**. The screen generation unit **52** generates screen information to be displayed on the communication terminal **30**. The screen information is created by Hypertext Markup Language (HTML), Extensible Markup Language (XML), Cascade Style Sheet (CSS), JavaScript®, or any other language for a web application to be executed by the communication terminal **30**. For a native application to be executed by the communication terminal **30**, the screen information is held by the communication terminal **30**, and the information to be displayed is transmitted in XML or the like. The screen generation unit **52** generates screen information of a screen on which a wide-view image or the like to be distributed by the image distribution unit **54** through the communication unit **51** is to be arranged.

The association processing unit **53** is mainly implemented in accordance with instructions from the CPU **501**. The association processing unit **53** performs control related to association and sharing of the point-of-view information of the wide-view image. In response to receipt of point-of-view information and an image capturing request from the communication terminal **30**, the association processing unit **53** performs a process of associating the point-of-view information with a wide-view image acquired from the image capturing apparatus **10** in response to an image capturing request. The wide-view image and point-of-view information, which are associated with each other, are stored in an image management information storage unit **5001** by the storing/reading unit **59**. Further, the association processing unit **53** transmits storage location information (e.g., URL) to the communication terminal **30** as information indicating a storage location where the associated wide-view image and point-of-view information are to be stored. In an example, the information processing system **50** does not simultaneously receive the point-of-view information and the image capturing request from the communication terminal **30**. The information processing system **50** separately receives the point-of-view information and the image capturing request and performs association processing. The URL is an example of storage location information indicating a storage location. The storage location information may be in any other format such as a uniform resource identifier (URI).

The image distribution unit **54** is mainly implemented in accordance with instructions from the CPU **501**. The image distribution unit **54** distributes, to the communication terminal **30** operated by a user who is in the virtual room, an image such as a wide-view image transmitted from the image capturing apparatus **10** associated with the same virtual room, through the communication unit **51**. An image having a normal angle of view captured by a camera included in the communication terminal **30** or the camera **8** or **9** connected to the communication terminal **30** is also distributed in a similar manner. The image to be distributed includes streaming video, a moving image, and a still image.

The authentication unit **55** is mainly implemented in accordance with instructions from the CPU **501**. The authentication unit **55** is a function of authenticating a request source in response to an authentication request received by

the communication unit **51**. For example, the authentication unit **55** determines whether authentication information (a user ID and a password) included in the authentication request received by the communication unit **51** matches authentication information held in advance to perform user authentication. The authentication information may be the card number of an integrated circuit (IC) card, biometric authentication information such as a face, a fingerprint, or a voiceprint, a device ID, a passcode, an access token, a security key, or a ticket. The authentication unit **55** may perform authentication using an external authentication system or an authentication method such as Open Authorization (Oauth). The authentication unit **55** may authenticate a device such as an image capturing apparatus, instead of a user.

The communication group management unit **56** is mainly implemented in accordance with instructions from the CPU **501**. The communication group management unit **56** manages the entry of the communication terminal **30** (or the user) into the virtual room, association between the virtual room and a device, and the like. Upon successful authentication of the user by the authentication unit **55**, the communication group management unit **56** registers the user ID and the Internet protocol (IP) address of the communication terminal **30** in a virtual room information storage unit **5002** or associates the image capturing apparatus **10** with the virtual room.

The communication control unit **57** is mainly implemented in accordance with instructions from the CPU **501**. The communication control unit **57** manages the start, establishment, and end of communication with the image capturing apparatus **10** associated with each virtual room. The communication control unit **57** also manages the start, establishment, and end of communication for distributing a wide-view image and (or) audio in response to the communication terminal **30** entering or leaving the virtual room.

The connection management unit **58** is mainly implemented in accordance with instructions from the CPU **501**. The connection management unit **58** manages communication (connection) established with the information processing system **50** by the communication terminal **30** and the image capturing apparatus **10** in association with the virtual room.

The API management unit **60** is mainly implemented in accordance with instructions from the CPU **501**. The API management unit **60** manages an API to be used by a platform contractor to provide an image distribution service of a wide-view image. In the use of the API, the platform contractor develops software for calling the API. The software to be developed may operate on a server or may operate on a client such as a communication terminal. Any of the functions of the information processing system **50**, such as the image distribution unit **54**, the association processing unit **53**, and the communication control unit **57**, can be provided as an API. Any function added to the information processing system **50** later may be provided as an API. To determine whether to provide a function as an API, a communication terminal operated by the platform provider accesses the information processing system **50** and accepts the public settings of the API. As a result, the API management unit **60** can control the API based on the public settings. The API management unit **60** may perform an authentication process for checking whether software operating on a request source that makes a request to call the API is software developed by an authorized platform contractor. The authentication process can be performed by comparing information registered and stored in advance in the storage unit **5000** as information on the platform contractor with information transmitted from the software operating on the request source.

In a specific example of the authentication process, the information processing system **50** receives, from the software operating on the request source, an application ID issued to the software developed by the platform contractor in advance by the API management unit **60**. If the API management unit **60** determines that the application ID matches an application ID stored in the storage unit **5000**, the API management unit **60** performs control to give permission to provide an API since the software developed by the platform contractor is determined as being valid. If the software developed by the platform contractor is not determined as being valid, the API management unit **60** performs control not to give permission to provide an API.

The application ID is an example of authentication information for determining validity. The API management unit **60** may use authentication information issued in advance by the API management unit **60** of the information processing system **50** or by an external system to check the validity of the request source. Examples of such authentication information include an access token, a ticket, a security key, a password, and a personal identification (PIN) code. In this embodiment, while the use of a function of the information processing system **50** as an API is not described, the same process flow is performed, except that software such as an application developed by a platform contractor uses a function of the information processing system **50** through a determination made by the API management unit **60**.

The storing/reading unit **59** is mainly implemented in accordance with instructions from the CPU **501**. The storing/reading unit **59** is a function of storing various data in the storage unit **5000** or reading various data from the storage unit **5000**.

Image Management Information Storage Unit **5001**

The storage unit **5000** includes the image management information storage unit **5001**. FIG. **14**A is a conceptual diagram illustrating image management information stored in the image management information storage unit **5001**. The image management information storage unit **5001** stores image management information as illustrated in FIG. **14**A. The image management information is information for managing wide-view images captured in response to image capturing requests. In response to a user transmitting an image capturing request from the communication terminal **30**, image management information for one record is generated. The items contained in the image management information will be described.

The item "data ID of wide-view image" is identification information for identifying data of a wide-view image. The information processing system **50** numbers each data ID. ID is an abbreviation for identification and means an identifier or identification information. ID is any one or a combination of two or more of a name, a symbol, a character string, and a numerical value that are used for uniquely identifying a specific object from among a plurality of objects. Each data ID may be associated with a wide-view image or an image captured at a normal angle of view by the image capturing apparatus **10** associated with the virtual room.

The item "data name" is the name of a wide-view image set by the user of the communication terminal **30**. Each data name may be set by the user or automatically.

The item "imaging start date and time information" is information that specifies the date and time of starting capturing an image such as a wide-view image. Examples of the imaging start date and time include the date and time

when the user input an image capturing start request to the communication terminal **30**, and the date and time when the image capturing apparatus **10** started capturing an image such as a wide-view image. The imaging start date and time information may be time stamp information of a captured image such as a wide-view image.

The item "imaging end date and time information" is information that specifies the date and time of ending capturing an image such as a wide-view image. Examples of the imaging end date and time include the date and time when the user input an image capturing end request to the communication terminal **30**, and the date and time when the image capturing apparatus **10** ended capturing an image such as a wide-view image. The imaging end date and time information may be time stamp information of a captured image such as a wide-view image.

For example, the first and second records from the top in FIG. **14**A manage wide-view images or the like that are captured images of the same location and were captured at different times on the same date.

The item "imaging operator information" is identification information (including a user ID or a user name) of a user (imaging operator) who has input an image capturing request to the communication terminal **30**. Since a user in a virtual room inputs an image capturing request to the communication terminal **30**, a user registered in the imaging operator information is identified by authentication to the information processing system **50** or the virtual room. The imaging operator information is transmitted to the information processing system **50** together with the image capturing request. In an example, the image capturing request and the imaging operator information are not transmitted to the information processing system **50** at the same time, and are transmitted to the information processing system **50** at different timings.

The item "image capturing apparatus information" is identification information (image capturing apparatus ID) of the image capturing apparatus **10** that has captured a wide-view image. The information processing system **50** numbers each image capturing apparatus ID and shares the image capturing apparatus ID with the image capturing apparatus **10**. The image capturing apparatus ID may be information unique to the image capturing apparatus **10**, such as a media access control (MAC) address or a serial number. The image capturing apparatus ID is transmitted to the information processing system **50** together with the associated wide-view image. In an example, the image capturing apparatus ID and the associated wide-view image are not transmitted to the information processing system **50** at the same time, and are transmitted to the information processing system **50** at different timings.

The item "imaging-time virtual room ID" is identification information of a virtual room associated with the image capturing apparatus **10**.

The item "data storage location information" is information indicating a location where the wide-view image is stored. The data storage location information is represented by a URL, a file path, or the like. In an example, the storage location identified by the storage location information may be information indicating a predetermined folder. The folder may be a folder associated with the imaging-time virtual room ID. The folder may be a folder associated with identification information (additional information such as a name) indicating any one or a combination of two or more of categories such as the imaging date and time, the image capturing apparatus, the imaging operator, and the imaging-time virtual room ID. In another example, the data storage location information may be used in combination with information such as the data ID and the data name to identify the data storage location.

The item "participant ID" is an example of user identification information for identifying a user who has participated in a virtual room identified by an imaging-time virtual room ID.

FIG. **14**B is a conceptual diagram illustrating image management information as a modification of the image management information illustrated in FIG. **14**A. In FIG. **14**B, wide-view images having the same imaging-time virtual room ID are stored. In this manner, image management information may be classified in units of virtual rooms.

Virtual Room Information Storage Unit **5002**

The storage unit **5000** includes the virtual room information storage unit **5002**. FIG. **15**A is a conceptual diagram illustrating virtual room information stored in the virtual room information storage unit **5002**. The virtual room information storage unit **5002** stores virtual room information as illustrated in FIG. **15**A. The virtual room information is information related to a virtual room. The virtual room information is held for each virtual room. The items contained in the virtual room information will be described. In an example, the virtual room is registered in a tenant. In another example, the virtual room is not registered in a tenant, and information on a temporarily created virtual room or a virtual room to be shared for use is also stored in the virtual room information storage unit **5002**.

The item "virtual room ID" is identification information that identifies the virtual room. In this embodiment, each virtual room can be created by a user as appropriate.

The item "virtual room name" is a name for the user to identify the virtual room. Each virtual room name can be set by a user as appropriate. The virtual room ID and the virtual room name may be the same information.

The item "device information" is identification information (device ID) of a device including the image capturing apparatus **10** associated with the virtual room.

The item "user in virtual room" is the user ID of a user who has entered and is currently in the virtual room. The user is a user authorized to view an image such as a wide-view image distributed to persons present in the virtual room. The method for entering a virtual room will be described below. The user ID may be associated with the IP address of the communication terminal **30** operated by the user. The user ID may be stored in association with a user name.

Tenant Information Storage Unit **5003**

The storage unit **5000** includes a tenant information storage unit **5003**. FIG. **15**B is a conceptual diagram illustrating tenant information stored in the tenant information storage unit **5003**. The tenant information storage unit **5003** stores tenant information as illustrated in FIG. **15**B. The tenant information is information related to a tenant (user group). The tenant information is held for each tenant. The items contained in the tenant information will be described. The tenant information includes various kinds of information other than those illustrated in FIG. **15**B, such as user information. FIG. **15**B illustrates part of the tenant information.

The item "tenant ID" is identification information that identifies the tenant.

The item "tenant name" is a name for the user to identify the tenant. The tenant ID and the tenant name may be the same information.

The item "tenant-registered virtual room ID" is identification information of a virtual room registered in the tenant.

The item "tenant-registered device" is information related to a device registered in the tenant.

The tenant information storage unit, the tenant ID, the tenant name, the tenant-registered virtual room ID, and the tenant-registered device may also be referred to as a user group information storage unit, a user group ID, a user group name, a user-group-registered virtual room ID, and a user-group-registered device, respectively.

Point-of-View Related Information Storage Unit **5004**

The storage unit **5000** includes a point-of-view related information storage unit **5004**. FIG. **16** is a conceptual diagram of point-of-view related information stored in the point-of-view related information storage unit **5004**. The point-of-view related information is associated with a data ID of a wide-view image, a participant ID, viewing start date and time information, and storage location information of point-of-view information. The data ID of the wide-view image and the participant ID have the same meanings as those of the corresponding items of the image management information illustrated in FIG. **14**A or **14**B.

The item "viewing start date and time information" indicates the date and time when a new predetermined-area image was started to be viewed in response to a change of a default (or initially set) predetermined-area image viewed at each site in the wide-view image being distributed at the recording time. In an example, information indicating the elapsed time for play back of one moving image may be used in place of the viewing start date and time.

The item "storage location information of point-of-view information" is information indicating a location where point-of-view information for identifying a predetermined area viewed at the date and time indicated by the viewing start date and time information of the same record is stored. The storage location information is represented by a URL, a file path, or the like.

The point-of-view related information illustrated in FIG. **16** makes it possible to leave a record indicating, for a predetermined wide-view image, when and at which site the communication terminal **30** (user) changed the default predetermined-area image to a desired predetermined-area image and displayed (viewed) the desired predetermined wide-view image

Entry of Communication Terminal into Virtual Room

Next, a process in which the user b enters a virtual room will be described with reference to FIGS. **17**A, **17**B, and **18**. In the illustrated example, the image capturing apparatus **10** has already been associated with the virtual room, and the communication terminal **30**A has transmitted a wide-view image and an image having a normal angle of view to the information processing system **50**. The association of the image capturing apparatus **10** with the virtual room and other operations will be described with reference to FIG. **19** and the subsequent figures. In the following description, no distinction is made between the entry of the user b into the virtual room and the entry of the communication terminal **30**B, which is operated by the user b, into the virtual room.

FIGS. **17**A and **17**B illustrate examples of a screen displayed on the communication terminal **30**B when the user b is to enter the virtual room. FIG. **17**A illustrates an example of a room entry screen **200**. Prior to the display of the room entry screen **200**, the user b logs into the information processing system **50**. Upon the login of the user b, the tenant to which the user b belongs is identified. Virtual rooms are associated with the tenant. A list of virtual rooms associated with the tenant is displayed on the communication terminal **30**B (see FIG. **22**), and the user b selects a virtual room that the user b is to enter from the list. FIG. **17**A illustrates the room entry screen **200** for the virtual room selected by the user b. A temporarily created virtual room or a sharable virtual room, which is not associated with the tenant, may be displayed on the screen illustrated in FIG. **17**A.

Alternatively, the creator of the virtual room may request the information processing system **50** to issue a URL corresponding to the virtual room, and the URL may be transmitted to the user b via email or any other suitable means. In response to the user b clicking on the URL displayed on the communication terminal **30**B, the communication terminal **30**B displays the room entry screen **200** illustrated in FIG. **17**A.

The room entry screen **200** includes a virtual room name **201**, a participant name input field **202**, and a room entry button **203**. The virtual room name **201** is the same as that stored in the virtual room information storage unit **5002**. The participant name input field **202** is a field for entering a user name to be displayed in the virtual room. The user name may be a name such as a nickname of the user b. Upon the login of the user b, a user name associated with the user ID of the user b may be identified. The identified user name may be automatically displayed. The room entry button **203** is a button for the user b to send a request to enter the virtual room.

At the time of entry into the virtual room, authentication for entering the virtual room may be requested separately from the login to the tenant.

FIG. **17**B illustrates an image viewing screen **210** displayed on the communication terminal **30**B upon the user b entering the virtual room. The image viewing screen **210** illustrated in FIG. **17**B indicates that the image capturing apparatus **10** has already started distributing a wide-view image via the information processing system **50** and that the communication terminal **30**A has already started distributing an image having a normal angle of view. The image viewing screen **210** includes a first image field **211** and a second image field **212**. The first image field **211** displays the wide-view image, and the second image field **212** displays the image having a normal angle of view. In an example, images are transmitted from three or more sites. The image viewing screen **210** is divided into a number of portions corresponding to the number of sites from which images are transmitted.

The first image field **211** displays a wide-view image mark **213**. The wide-view image mark **213** is set by the screen generation unit **52** of the information processing system **50** upon determination that the image to be displayed in the first image field **211** is a wide-view image. The determination may be made by the communication terminal **30**B, and the communication terminal **30**B may display the wide-view image mark **213**. The wide-view image mark **213** allows the user b to know that a wide-view image for which the point of view can be changed has been distributed. The first image field **211** also displays a device name **214**. The device name **214** is transmitted from the image capturing apparatus **10** together with the wide-view image. The device name **214** is information set by the user a or the like (see FIG. **20**A), as described below.

The second image field **212** displays a participant name **215**. The participant name **215** is a user name. The participant name of a user who has already entered the virtual room is displayed in the participant name input field **202**. In the illustrated example, since the user a has already entered the virtual room, "AAA", which is entered by the user a in the participant name input field **202**, is displayed in the participant name input field **202**.

FIG. **18** is a sequence diagram illustrating a process in which the user b (or the communication terminal **30**B) enters the virtual room.

S**1**: First, the user b at the site B performs an operation of displaying a virtual room list screen. The communication terminal **30**B accesses the information processing system **50** in advance in response to an operation performed by the user b, and receives, from the information processing system **50**, information on the virtual rooms stored in the virtual room information storage unit **5002** to display a virtual room list screen. At this time, the communication terminal **30**B may transmit authentication information used for login or the like to the information processing system **50** and may be authenticated by the authentication unit **55** of the information processing system **50**. The authentication information may be authentication information associated with the user b or authentication information associated with the communication terminal **30**B. The virtual rooms displayed in the virtual room list screen may be virtual rooms registered in the tenant associated with the user b or virtual rooms registered in the tenant associated with the communication terminal **30**B. In response to the acceptance unit **32** accepting the operation of displaying the virtual room list screen, the display control unit **33** of the communication terminal **30**B causes the display **306** to display a selection screen.

S**2**: In response to the user b selecting a selection button for one of the virtual rooms, the acceptance unit **32** of the communication terminal **30**B accepts the selection of the virtual room. The display control unit **33** of the communication terminal **30**B causes the display **306** to display the room entry screen **200** illustrated in FIG. **17**A.

S**3**: The user b completes the items and then presses the room entry button **203**. In response to the acceptance unit **32** accepting the pressing of the room entry button **203**, the communication unit **31** of the communication terminal **30**B transmits a request to the information processing system **50** to enter the virtual room. The request for entering the virtual room includes information such as a virtual room ID indicating the virtual room selected in step S**2**, the user ID of the user b authenticated by login or the like, and the IP address of the communication terminal **30**B from which the request is transmitted. Then, the communication unit **51** of the information processing system **50** receives the request for entering the virtual room.

S**4**: The communication group management unit **56** registers the IP address and the user ID authenticated by login or the like in the virtual room information identified by the virtual room ID in the virtual room information storage unit **5002**.

S**5**: The communication unit **51** of the information processing system **50** transmits, to the communication terminal **30**B, a response indicating that the communication terminal **30**B has already entered the virtual room. Then, the communication unit **31** of the communication terminal **30**B receives the response indicating that the communication terminal **30**B has already entered the virtual room. After step S**5**, the display control unit **33** of the communication terminal **30**B receives information on a screen generated by the screen generation unit **52** of the information processing system **50** and information on the image distributed by the image distribution unit **54**, and causes the image viewing screen **210** illustrated in FIG. **17**B to be displayed based on the received information.

Association of Image Capturing Apparatus with Room

Next, an association of the image capturing apparatus **10** with a virtual room will be described with reference to FIGS. **19** to **26**. In an example, the user a at the site A associates the image capturing apparatus **10** with a virtual room. In another example, a system administrator, a tenant administrator, or the like associates the image capturing apparatus **10** with a virtual room.

FIG. **19** illustrates an example of a device registration screen **220** displayed on the communication terminal **30**A. The user a has been authenticated by the information processing system **50** by login or the like Upon the login of the user a, the tenant to which the user a belongs is identified. The user a requests the information processing system **50** to display the device registration screen **220**. The communication terminal **30**A displays the device registration screen **220** received from the information processing system **50**. First, a device is registered in the tenant on the device registration screen **220**.

The device registration screen **220** includes an image capturing apparatus registration button **221**, a VR goggles registration button **222**, and a smart glasses registration button **223**. Buttons are provided for the respective types of devices because the devices are different in the presence or absence of a camera information used for registration, or the like. Since devices are registered on a per-type basis, the information processing system **50** can also grasp the types of the devices.

The image capturing apparatus registration button **221** is a button for the user a to register the image capturing apparatus **10**. The VR goggles registration button **222** is a button for the user a to register the VR goggles **89**. The smart glasses registration button **223** is a button for the user a to register the smart glasses **88**.

FIGS. **20**A and **20**B illustrate an example of screens displayed in response to the pressing of the image capturing apparatus registration button **221**. FIG. **20**A illustrates an image capturing apparatus registration dialog **230**. The image capturing apparatus registration dialog **230** includes a name field **231** for the image capturing apparatus **10**, a description field **232** for the image capturing apparatus **10**, and a next button **233**. The user a sets any name in the name field **231** for the image capturing apparatus **10** and sets a description in the description field **232** for the image capturing apparatus **10** such that the image capturing apparatus **10** to be registered can be identified.

In response to the user a pressing the next button **233**, the communication terminal **30**A requests a two-dimensional code from the information processing system **50**. The communication terminal **30**A displays the two-dimensional code.

FIG. **20**B illustrates an example of a two-dimensional code screen **240** displayed on the communication terminal **30**A. The two-dimensional code screen **240** includes a message **241** and a two-dimensional code **242**. The message **241** indicates "Scan the two-dimensional code below to register the device named xxx (xxx is the name entered in the name field **231**)". The user a captures an image of the two-dimensional code **242** with the image capturing apparatus **10** to be registered. The two-dimensional code **242** includes a URL to which the image capturing apparatus **10** connects to register the image capturing apparatus **10**, and authentication information used for registration, such as a temporary ID and a password.

In response to the user a capturing the two-dimensional code **242** with the image capturing apparatus **10**, the image capturing apparatus **10** connects to the URL and is authenticated using the temporary ID and the password. If the authentication is successful, the temporary ID is replaced with a formal image capturing apparatus ID, and the name, the description, and the image capturing apparatus ID of the

image capturing apparatus **10** are registered in the tenant. The image capturing apparatus **10** also holds the image capturing apparatus ID, the name, and the description. The image capturing apparatus **10** registered in the tenant is associated with the virtual room in response to an operation performed by the user a described below. The two-dimensional code **242** is an example of code information and has embedded therein similar authentication information. In another example, the two-dimensional code **242** is any other form of code such as a barcode.

Next, an example method for registering a communication terminal such as the VR goggles **89** or the smart glasses **88** in a tenant will be described with reference to FIG. **21**. FIG. **21** illustrates an example of a VR goggles registration screen **250** displayed in response to the pressing of the VR goggles registration button **222**. The VR goggles registration screen **250** includes a temporary code input field **251** and a secret input field **252**.

Without a camera, it is difficult for the VR goggles **89** to capture an image of a two-dimensional code. A temporary code (temporary ID) and a secret (password) may be output from (displayed on) the VR goggles **89**, and the user a may enter the temporary code and the secret to the temporary code input field **251** and the secret input field **252**, respectively. The communication terminal **30**A transmits the temporary code and the secret to the information processing system **50** to register the VR goggles **89** in the tenant. The VR goggles **89** connect to the information processing system **50** and transmit the temporary code and the secret. As a result, the VR goggles **89** are authenticated by the information processing system **50**. If the authentication is successful, the temporary code is replaced with a formal VR goggles ID, and the VR goggles ID is registered in the tenant. The VR goggles **89** also hold the VR goggles ID. The VR goggles **89** registered in the tenant are associated with a virtual room in response to an operation performed by the user a described below.

The smart glasses **88** can also be registered by the user a in a manner similar to that for the image capturing apparatus **10** or the VR goggles **89**, as will be described in detail. The temporary code and the secret are an example of authentication information. Other information may be used as authentication information. The image capturing apparatus ID, the VR goggles ID, and the smart glasses ID are each an example of a device ID and may also be referred to as device IDs. A device other than the image capturing apparatus **10**, VR goggles, and smart glasses may be registered by using a device ID for associating the device with a virtual room or a tenant in a similar procedure. The device ID may be identification information associated with the owner of the device.

FIG. **22** illustrates an example of a first virtual room association screen **260** for associating the image capturing apparatus **10** with a virtual room. The same screen configuration may be used for the VR goggles **89** and the smart glasses **88**. The first virtual room association screen **260** includes a virtual room list **261**. The virtual room list **261** displays individual virtual room fields **262** to **264**, based on virtual rooms created in the tenant. Each of the individual virtual room fields **262** to **264** includes a link issuance button **265**, a room entry button **266**, a settings button **267**, and a virtual room name **268**. The link issuance button **265** is a button for issuing a link (a URL for invitation) to the corresponding virtual room and a passcode. The room entry button **266** is a button for the user a to enter the virtual room. The settings button **267** is a button for associating the image capturing apparatus **10** with the virtual room. The virtual room name **268** is the same as that stored in the virtual room information storage unit **5002**. The user a presses the settings button **267**. In response to the pressing of the settings button **267**, the communication terminal **30**A displays a second virtual room association screen **270** illustrated in FIG. **23**.

If a device has already been associated with the virtual room, a name **269** of the device is displayed in the individual virtual room field (in FIG. **22**, the individual virtual room field **264**).

FIG. **23** illustrates an example of the second virtual room association screen **270**. The second virtual room association screen **270** is displayed as a pop-up on the first virtual room association screen **260**. In an example, the screen transition from the first virtual room association screen **260** to the second virtual room association screen **270** is not made through the information processing system **50**. In another example, the screen transition from the first virtual room association screen **260** to the second virtual room association screen **270** is made through the information processing system **50**.

The second virtual room association screen **270** includes a name **271** of the image capturing apparatus **10** that is currently (or has already been) associated with the virtual room, a connection button **272**, and a storage button **273**, and a "Save" button **274**. In FIG. **23**, the name **271** is set unregistered because the image capturing apparatus **10** is not registered yet. The connection button **272** is a button for displaying a list of devices registered in the tenant as candidates to be associated with the virtual room to associate a device with the virtual room. The storage button **273** is a button for displaying a list of storages **90** to store an image having a normal angle of view or a wide-view image captured by the image capturing apparatus **10** associated with the virtual room. Examples of the list of storages **90** may include a list of storages **90** to be associated with the virtual room and a list of specific storage locations such as folders in the storages **90**. The user a selects a predetermined storage **90** or a specific storage location such as a folder in the storage **90** to associate the storage **90** with the virtual room. Information on the storage **90** associated with the virtual room in the way described above can be stored in the virtual room information storage unit **5002** in association with the virtual room ID. Examples of the information on the storage **90** include address information for accessing the storage **90** and a storage location such as a folder in the storage **90**. In response to the pressing of the connection button **272**, the communication terminal **30**A displays a third virtual room association screen.

The communication terminal **30**A transmits a virtual room ID to the information processing system **50** and acquires the name (or ID) of a device registered in the tenant for which the virtual room is generated and the name (or ID) of a device associated with the virtual room.

FIG. **24** illustrates an example of a third virtual room association screen **280**. The third virtual room association screen **280** includes a name **281** of the image capturing apparatus **10** that is currently (or has already been) associated with the virtual room, a list of devices **282** that can be added, and a "Save" button **283**. The user a selects a device to be additionally associated with the virtual room from the list of devices **282** that can be added and then presses the "Save" button **283**. As a result, the selected device is associated with the virtual room. That is, a device ID such as an image capturing apparatus ID is registered in the virtual room information storage unit **5002**. As illustrated in FIG. **24**, the number of image capturing apparatuses to be

associated with the virtual room may be limited. In an example, the upper limit is two. In this case, the number of image capturing apparatus IDs that have already been registered in the virtual room information storage unit **5002** may be referred to, and the remaining number of devices that can be additionally registered may be displayed on the third virtual room association screen **280**.

Wide-View Image Transmission Start Process for Image Capturing Apparatus

In the way described above, a device such as the image capturing apparatus **10** is associated with the virtual room. The user a operates the device to start transmitting an image.

For the VR goggles **89** and the smart glasses **88**, the user a operates the device main body to turn on or off the transmission of an image. This is because no application dedicated to the communication system **1***a* is currently operating on the VR goggles **89** or the smart glasses **88**. If an application dedicated to the communication system **1***a* operates on the VR goggles **89** and the smart glasses **88**, the user a can also remotely turn on or off the transmission of an image.

For the image capturing apparatus **10**, when the application is enabled, the user a can turn on or off the transmission of the wide-view image from the menu of the application after entering the virtual room.

FIGS. **25**A and **25**B illustrate examples of a wide-view image transmission control dialog **290** displayed on the communication terminal **30**A. The wide-view image transmission control dialog **290** is displayed as a pop-up on the image viewing screen **210**. In the illustrated example, the user a has operated the communication terminal **30**A to cause the image capturing apparatus **10** to enter the associated virtual room. The wide-view image transmission control dialog **290** displays a name **292** of the image capturing apparatus **10** associated with the virtual room. A toggle button **291** is displayed near the name **292**. The user a can operate the toggle button **291** to set the transmission of the wide-view image captured by the image capturing apparatus **10** to on (start of transmission) or off (stop of transmission). The setting of on or off using a toggle button is an example. The start or stop of transmission of the wide-view image may be set in accordance with an input of a user operation. In an example, the start or stop of transmission of the wide-view image may be set in response to selection of a radio button or a predetermined icon or in response to a menu operation. In another example, the transmission of the wide-view image is started automatically, without the user's operation, after the image capturing apparatus **10** enters the room. In another example, a predetermined condition such as the date and time, the number of users who have entered the room, or the participation of a specific user is determined in advance, and the transmission of the wide-view image is started in response to a determination that the predetermined condition is satisfied.

The communication terminal **30**A transmits transmission control setting information, which is set in response to an operation of the toggle button **291**, to the information processing system **50**. The information processing system **50** transmits a transmission start request or a transmission stop request corresponding to the transmission control setting information to the image capturing apparatus **10**.

FIG. **25**A illustrates the "off" setting of the toggle button **291**. In FIG. **25**A, thus, the wide-view image is not displayed. By contrast, the image having a normal angle of view captured by the camera **9** of the communication terminal **30**A is displayed in the image viewing screen **210** in FIG. **25**A since the image having a normal angle of view has already been shared at the time of entry of the communication terminal **30**A into the virtual room.

FIG. **25**B illustrates the "on" setting of the toggle button **291**. The information processing system **50** transmits a transmission start request to the image capturing apparatus **10** in response to the toggle button **291** being turned on, and the image capturing apparatus **10** starts transmitting the wide-view image. Since two images are shared in one virtual room, the image viewing screen **210** is divided into two areas. Upon the setting being changed from the "on" setting to the "off" setting, the communication terminal **30**A transmits "off" setting information to the information processing system **50**. The information processing system **50** transmits a transmission stop request to the image capturing apparatus **10** in response to receipt of the "off" setting information, and the image capturing apparatus **10** stops the transmission of the wide-view image.

As described with reference to FIG. **26**, a user who is even on site can perform a simple operation such as capturing an image of code information with the image capturing apparatus **10** to associate the image capturing apparatus **10** with the virtual room. In some cases, a user who is on site does not carry a PC or the like. It is useful that such a user who is on site can perform the association process on-site by using the image capturing apparatus **10** and code information issued in advance. In an example, if the user performs the association process in advance, the user can connect the image capturing apparatus **10** to a predetermined virtual room without selecting the virtual room or performing any additional operation. In addition, the user can provide an instruction to start or stop transmission from a remote site. This can reduce the burden on the user who desires to concentrate on work on-site. Accordingly, even in a preparation process, it is possible to provide a system that enables efficient communication between on-site and remote users.

Procedure for Registering Image Capturing Apparatus in Virtual Room

Next, a procedure for registering the image capturing apparatus **10** in the virtual room illustrated in the series of screen transitions in FIGS. **19** to **25**B will be described with reference to FIG. **26**. FIG. **26** is a sequence diagram illustrating an example procedure in which the user a registers the image capturing apparatus **10** in the virtual room.

S**11**: First, the user a connects the communication terminal **30**A to the information processing system **50** and enters authentication information (such as a user ID and a password) to send a login request. The acceptance unit **32** of the communication terminal **30**A accepts the operation.

S**12**: The communication unit **31** of the communication terminal **30**A designates the authentication information and transmits the login request to the information processing system **50**. The communication unit **51** of the information processing system **50** receives the login request, and the authentication unit **55** performs authentication based on the designated authentication information. It is assumed that the authentication is successful. At this time, the information processing system **50** refers to the tenant information storage unit **5003** to identify the tenant ID associated with the authenticated user ID.

S**13**: The screen generation unit **52** of the information processing system **50** generates the device registration screen **220** in response to the user operation, and the communication unit **51** transmits screen information of the device registration screen **220** to the communication terminal **30**A.

S**14**: The communication unit **31** of the communication terminal **30**A receives the screen information of the device

registration screen **220**, and the display control unit **33** displays the device registration screen **220** illustrated in FIG. **19**. The user a selects the type of the device (in the illustrated example, the image capturing apparatus **10** (e.g., a spherical camera)). Then, as illustrated in FIG. **20**A, the user a enters the name and description of the image capturing apparatus **10**. The acceptance unit **32** accepts the entered information.

S**15**: The communication unit **31** of the communication terminal **30**A designates the name and description entered by the user a and transmits a request for code information (e.g., a two-dimensional code) to the information processing system **50**.

S**16**: The communication unit **51** of the information processing system **50** receives the request for code information (e.g., a two-dimensional code). The communication group management unit **56** generates a URL (connection destination for registration) in association with the name and the description, and generates code information (e.g., a two-dimensional code) including the URL, a temporary ID, and a password. The communication unit **51** of the information processing system **50** transmits the code information (e.g., a two-dimensional code) to the communication terminal **30**A. The communication unit **31** of the communication terminal **30**A receives the code information (e.g., a two-dimensional code). Then, the display control unit **33** displays the code information (e.g., a two-dimensional code), as illustrated in FIG. **20**B.

S**17**: The user a operates the image capturing apparatus **10** to be associated with the virtual room to capture an image of the code information (e.g., a two-dimensional code). The acceptance unit **12** of the image capturing apparatus **10** accepts the operation.

S**18**: The imaging processing unit **13** of the image capturing apparatus **10** performs an imaging process on an imaging target including the code information (e.g., a two-dimensional code) to generate image data, and the analysis unit **14** analyzes the image data to extract the URL, the temporary ID, and the password. Accordingly, the registration request unit **15** connects to the URL via the connection unit **16**, designates the temporary ID and the password, and transmits a request for registering the image capturing apparatus **10** to the information processing system **50**. In the registration method using the registration screen illustrated in FIG. **21**, an image of the code information is not captured. Thus, the image capturing apparatus **10** is replaced with a communication terminal such as the VR goggles **89** or the smart glasses **88**, and the processing of steps S**15** to S**17** can be omitted.

S**19**: The communication unit **51** of the information processing system **50** receives the temporary ID and the password, and the authentication unit **55** determines whether the received temporary ID and password match the temporary ID and password associated with the connected URL. It is assumed that a match is found.

S**20**: Since a request for registering the image capturing apparatus **10** has been made, the communication group management unit **56** of the information processing system **50** generates an image capturing apparatus ID as an example of a device ID and registers the image capturing apparatus ID in the tenant corresponding to the tenant ID identified at the time of the login of the user a. The image capturing apparatus ID is associated with a name and a description. Specifically, the communication group management unit **56** refers to the tenant information storage unit **5003** and additionally registers the image capturing apparatus ID in the tenant-registered device associated with the identified tenant ID. In the illustrated example, the communication group management unit **56** generates and registers an image capturing apparatus ID. In another example, the communication group management unit **56** registers an image capturing apparatus ID received from the image capturing apparatus **10**. In the registration of, instead of the image capturing apparatus **10**, a communication terminal such as the VR goggles **89** or the smart glasses **88** in the tenant, a device ID corresponding to the communication terminal can be registered in the tenant information storage unit **5003** in a similar procedure.

S**21**: The communication unit **51** of the information processing system **50** transmits the image capturing apparatus ID to the image capturing apparatus **10**. The connection unit **16** of the image capturing apparatus **10** receives the image capturing apparatus ID and stores the image capturing apparatus ID in the storage unit **1000**.

S**22**: The communication terminal **30**A is notified of the completion of the registration by the communication unit **51** of the information processing system **50**, and the user a can start associating the image capturing apparatus **10** with the virtual room in response to the notification. The user a selects, from the first virtual room association screen **260** displayed on the communication terminal **30**A, a virtual room with which the user a desires to associate the image capturing apparatus **10** registered in the tenant. The acceptance unit **32** of the communication terminal **30**A accepts an operation input indicating selection. Specifically, in response to the acceptance unit **32** of the communication terminal **30**A accepting an operation input from the user a, the display control unit **33** causes the first virtual room association screen **260** to be displayed. At this time, the communication unit **31** may transmit a screen update request to the communication unit **51** of the information processing system **50**. In response to receipt of the screen update request, the information processing system **50** refers to the tenant information storage unit **5003** and identifies a virtual room ID registered in the tenant associated with the authenticated user ID. The information processing system **50** further refers to the virtual room information storage unit **5002** and acquires the virtual room name associated with the identified virtual room ID. The communication unit **51** of the information processing system **50** transmits information on the identified virtual room ID and a virtual room name corresponding to the identified virtual room ID (or information on a screen generated by the screen generation unit **52** based on such information) to the communication terminal **30**A. The communication unit **31** of the communication terminal **30**A receives the information on the virtual room ID and the virtual room name. The display control unit **33** can update and display the first virtual room association screen **260** in accordance with the received information. Such information, which can be identified based on the user ID, may be received in step S**13** after the authentication. The acceptance unit **32** accepts an operation input indicating selection from the user a on the displayed first virtual room association screen **260**. As a result, the communication terminal **30**A can identify the virtual room ID that has been selected.

S**23**: The user a presses, on the second virtual room association screen **270** displayed on the communication terminal **30**A, the connection button **272** to additionally associate a device with the virtual room. The acceptance unit **32** of the communication terminal **30**A accepts an operation input indicating the pressing of the connection button **272**. Specifically, the display control unit **33** of the communication terminal **30**A displays the second virtual room association screen **270** corresponding to the selected virtual room

ID identified in step S22. Further, the acceptance unit 32 accepts, from the user a, an instruction to additionally associate a device with the virtual room (the pressing of the connection button 272).

S24: In response to the operation input in step S23, the communication unit 31 of the communication terminal 30A requests the information processing system 50 to provide information on devices registered in the tenant, which are candidate devices to be associated with the virtual room, and devices that have already been associated with the virtual room ID selected in step S22.

S25: The communication unit 51 of the information processing system 50 receives the request for the information on the devices registered in the tenant and the devices associated with the selected virtual room ID, and the screen generation unit 52 generates the third virtual room association screen 280 including the device IDs of the devices registered in the tenant and the devices associated with the selected virtual room ID. The communication unit 51 of the information processing system 50 transmits screen information of the third virtual room association screen 280 to the communication terminal 30A.

S26: The communication unit 31 of the communication terminal 30A receives the screen information of the third virtual room association screen 280, and the display control unit 33 causes the third virtual room association screen 280 to be displayed. The user a selects a device to be associated with the virtual room. In an example, the user a selects the image capturing apparatus 10. The acceptance unit 32 of the communication terminal 30A accepts the selection, and the image capturing apparatus ID is identified as the device ID of the selected device.

S27: The communication unit 31 of the communication terminal 30A designates the virtual room ID selected in step S22 and the device ID (e.g., the image capturing apparatus ID) selected in step S26, and transmits an association request to the information processing system 50.

S28: The communication unit 51 of the information processing system 50 receives the association request, and the communication group management unit 56 registers the device (e.g., the image capturing apparatus 10) in the virtual room. That is, the communication group management unit 56 refers to the virtual room information storage unit 5002 and registers the device ID (e.g., the image capturing apparatus ID) in association with the virtual room ID designated in the request sent in step S27.

S29: Since the device ID (e.g., the image capturing apparatus ID) is associated with the virtual room, the communication unit 51 of the information processing system 50 transmits the virtual room ID, the name, and the description to the image capturing apparatus 10. The information processing system 50 may transmit the virtual room ID, the name, and the description to the image capturing apparatus 10 by using a push notification or by using polling, which is performed by the image capturing apparatus 10. The connection unit 16 of the image capturing apparatus 10 receives the virtual room ID, the name, and the description and stores the virtual room ID, the name, and the description in the storage unit 1000. Accordingly, the image capturing apparatus 10 can add the image capturing apparatus ID, the virtual room ID, the name, the description, and the like to a wide-view image to be transmitted. A device other than the image capturing apparatus 10 can also be associated with the virtual room in a similar procedure. Then, the communication unit 51 of the information processing system 50 may transmit a notification indicating completion of the association to the communication terminal 30A. After step S29, the device (the image capturing apparatus 10) registered in association with the virtual room can connect to the associated virtual room. In the illustrated example, the image capturing apparatus 10 designates the virtual room ID received in step S29 and transmits a virtual room connection request to the information processing system 50, thereby connecting to the virtual room. The timing at which the image capturing apparatus 10 connects to the virtual room can be changed in accordance with an operation performed by the user.

S30: The communication terminal 30A and the information processing system 50 perform the room entry process illustrated in FIG. 18 to allow the communication terminal 30A to enter the virtual room associated with the device (the image capturing apparatus 10).

S31: After entry into the virtual room, the user a turns on the toggle button 291, on the image viewing screen 210, for the image capturing apparatus 10 associated with the virtual room. The acceptance unit 32 of the communication terminal 30A accepts the turn-on operation.

S32: The communication unit 31 of the communication terminal 30A designates the device ID (image capturing apparatus ID) and transmits, to the information processing system 50, a request for starting transmission of the wide-view image. The user a may directly operate a button of the image capturing apparatus 10 to start transmitting the wide-view image. In response to an operation performed by the user a, the communication unit 31 of the communication terminal 30A may transmit a transmission stop request to the information processing system 50.

S33: The communication unit 51 of the information processing system 50 receives the transmission start request and requests the image capturing apparatus 10 identified by the device ID (image capturing apparatus ID) to start transmission. The information processing system 50 may use a push notification or use polling, which is performed by the image capturing apparatus 10. The connection unit 16 of the image capturing apparatus 10 receives the transmission start request, and the imaging processing unit 13 starts capturing a wide-view image.

The image transmission control unit 18 repeatedly transmits the wide-view image with a determined frame rate (expressed in FPS) or a frame rate (expressed in FPS) corresponding to a band via the connection unit 16. As a result, the communication terminal 30 that has entered the virtual room can display the state of the site A on the image viewing screen 210 in real time.

Distribution of Wide-View Image and Others

A process for sharing a wide-view image or an image having a normal angle of view will be described with reference to FIG. 27. FIG. 27 is a sequence diagram illustrating an example process for sharing a wide-view image. In FIG. 27, the communication terminals 30A and 30B have entered the virtual room by executing the room entry process described with reference to FIG. 18. The communication terminal 30A includes the camera 9 having a normal angle of view, and an image captured by the camera 9 is shared with the communication terminal 30B. An image captured by the smart glasses 88 associated with the virtual room, instead of the camera 9 of the communication terminal 30A, may be shared. In FIG. 27, the image capturing apparatus 10 has already connected to the same virtual room in accordance with the registration procedure illustrated in FIG. 26.

S41: The imaging unit 34 of the communication terminal 30A captures an image of an object and the surroundings of the object, and the communication unit 31 designates the virtual room ID of the virtual room that the communication

terminal **30**A is in and transmits video including the captured image and audio to the information processing system **50**.

S**42** and S**43**: In response to the communication unit **51** of the information processing system **50** receiving the video including the image and the audio, the image distribution unit **54** acquires the IP addresses of the communication terminals **30**A and **30**B, which are in the same virtual room, from the virtual room information storage unit **5002**, and transmits the video including the image and the audio via the communication unit **51**. In FIG. **27**, an image having a normal angle of view is received by the communication unit **31** of the communication terminal **30**A from the information processing system **50** and is displayed. In another example, an image having a normal angle of view is not received from the information processing system **50**, but an image having a normal angle of view is captured by the imaging unit **34** and is displayed.

S**44**: In response to a transmission start request based on the settings for starting transmission, the imaging processing unit **13** of the image capturing apparatus **10** captures a wide-view image, and the image transmission control unit **18** designates the virtual room ID of the virtual room in which the image capturing apparatus **10** is registered, the image capturing apparatus ID, and the name and the description of the image capturing apparatus **10** and transmits video including the wide-view image and audio to the information processing system **50** via the connection unit **16**.

S**45** and S**46**: In response to the communication unit **51** of the information processing system **50** receiving the video including the wide-view image and the audio, the image distribution unit **54** acquires the IP addresses of the communication terminals **30**A and **30**B, which are in the same virtual room, from the virtual room information storage unit **5002**, and transmits the video including the wide-view image and the audio via the communication unit **51**.

S**47**: The communication terminal **30**C including the camera **9** executes the room entry process illustrated in FIG. **18** and newly enters the virtual room.

S**48**: The communication unit **31** of the communication terminal **30**C transmits video including an image having a normal angle of view and audio to the information processing system **50**.

S**49** to S**51**: The communication unit **51** of the information processing system **50** receives the video including the image having a normal angle of view and the audio from the communication terminal **30**C, and the image distribution unit **54** acquires the IP addresses of the communication terminals **30**A to **30**C, which are in the same virtual room, from the virtual room information storage unit **5002**, and transmits the video including the image having a normal angle of view and the audio.

S**52**: The communication unit **51** of the information processing system **50** also transmits the video including the wide-view image and the audio to the communication terminal **30**C, which is in the same virtual room.

As described above, the users a and b, who are in the same virtual room, can share, in real time, the video including the wide-view image captured by the image capturing apparatus **10** associated with the virtual room. The order of transmission of the images illustrated in FIG. **27** is an example. In another example, the wide-view image may be shared first, or the image having a normal angle of view may be shared first.

A supplementary description will now be given of the smart glasses **88** and the VR goggles **89**. The smart glasses **88** have a camera having a normal angle of view and a display function. The camera of the smart glasses **88** captures an image having a normal angle of view, and the captured image having a normal angle of view is distributed in a manner similar to that for the cameras **8** and **9**. The display function of the smart glasses **88** is implemented by a flat screen, like that of an ordinary display. Thus, part of the wide-view image is displayed from a point of view designated by the user. The VR goggles **89** have a display function. In an example, the VR goggles **89** may also include a camera having a normal angle of view. The display function of the VR goggles **89** projects a wide-view image with a point of view determined by the orientation of the head of the user wearing the VR goggles **89**. Thus, the predetermined-area image Q of the predetermined area T in the wide-view image is displayed from a point of view corresponding to the orientation of the head of the user. While viewing a wide-view image with the smart glasses **88** or the VR goggles **89**, the user can transmit, to the information processing system **50**, an image capturing request that designates point-of-view information of the wide-view image being viewed.

Recording with Image Capturing Apparatus in Response to Instruction from Communication Terminal

Next, a process in which the image capturing apparatus **10** performs recording in response to an instruction from any communication terminal **30** will be described with reference to FIGS. **29** to **34**.

First, a description will be given of a screen on which a user issues a recording request to the image capturing apparatus **10** by operating the communication terminal **30** in the sharing of a wide-view image. Any user can provide a recording instruction. In the illustrated example, the user b gives a recording instruction. In the sharing of a wide-view image, to be exact, the image capturing apparatus **10** performs an "image capturing operation" in real time. The recording request in the sharing of a wide-view image is a request for recording the wide-view image for storage. In simple real-time distribution of a wide-view image, the wide-view image is not stored and is difficult to check at a later time. That is, a certain scene is not optionally stored.

FIG. **29** illustrates an example of an image viewing screen **400** displayed on the communication terminal **30**B. In the description of FIG. **29**, differences from FIG. **25**B will mainly be described. The communication terminals **30**A and **30**B display the video including the wide-view image distributed in real time. The communication terminals **30**A and **30**B also display the video including the image having a normal angle of view captured by the camera **9** of the communication terminal **30**A. In the video including the wide-view image, the virtual point of view (see FIG. **11**) can be changed as desired by operation of each of the users a and b at the sites A and B to change the predetermined area T (see FIGS. **9** and **10**A to **10**D) in the wide-view image to be displayed. As a result, even part of the on-site situation that is difficult to view at a normal angle of view is also visible.

As illustrated in FIG. **29**, the first image field **211** in which the wide-view image is displayed displays a recording button **401**. The recording button **401** is a button for the communication terminal **30**B to transmit a recording request to the image capturing apparatus **10** by using point-of-view information for identifying a predetermined area of the video including the wide-view image displayed in the first image field **211**. In FIG. **29**, the recording button **401** is given the description "Record 360-degree video". The recording button **401** is an example of a button for recording video of a spherical image, which is an example of a wide-view image. In another example, the recording button

401 may be a button given any other description, or a button represented by an image such as an icon without description. In another example, the recording button 401 may be a button for instructing recording of a wide-view image other than a spherical image. The recording button 401 is not limited to that in the example illustrated in FIG. 29 as long as the recording button 401 is a component of a graphical user interface (GUI) that can be used to provide a recording instruction.

FIG. 30 illustrates the image viewing screen 400 on which a download button 402 is displayed in response to the pressing of the recording button 401 on the communication terminal 30B. In FIG. 30, the download button 402 (an example of a display component) is displayed below the first image field 211. The download button 402 displays the message "Download recorded video". The download button 402 has embedded therein storage location information (e.g., URL) of a storage location to which the wide-view image recorded by the image capturing apparatus 10 in accordance with the recording request transmitted in response to the pressing of the recording button 401 is uploaded. In response to the user b pressing the download button 402, the communication terminal 30B connects to the URL and can download the recorded wide-view image. Since the wide-view image is associated with the point-of-view information, the communication terminal 30B displays the downloaded wide-view image by setting and displaying a virtual point of view such that a predetermined area identified by the point-of-view information and included in the wide-view image matches the center of the first image field 211. In an example, the downloaded wide-view image is associated with items of point-of-view information of a plurality of sites. The user inputs selection of one of options on the screen to determine which of the items of point-of-view information of the plurality of sites to use to display a predetermined area. In response to receipt of the input from the user, the predetermined area based on the selected point-of-view information may be displayed. It should be noted that the point of view is not necessarily made to completely match the center of the image field. In an example, the point of view may be set and displayed so as to be included in a range near the center of the first image field 211. In the illustrated example, the downloaded wide-view image is displayed in the first image field 211 in which the video including the wide-view image distributed in real time is displayed. In another example, a new image field is added to the image viewing screen 400, and the downloaded wide-view image is displayed in the new image field while the video including the wide-view image distributed in real time is continuously displayed in the first image field 211 as it is. This allows the user b to view a change in the on-site situation from the video including the wide-view image video distributed in real time and to also view a wide-view image of a specific part of the on-site situation at the same time.

The form of the download button 402 is an example. The download button 402 may display a message such as "spherical image URL". The download button 402 may display, instead of a button, a link corresponding to the storage location information (e.g., URL). The user b may download the wide-view image by clicking on the link.

In another example, the communication terminal 30B does not display the download button 402, and automatically receives and displays the stored wide-view image and the associated point-of-view information.

The image viewing screen 400 illustrated in FIG. 30 is displayed on the communication terminal 30B from which the recording request is transmitted. The download button 402 may be displayed on the image viewing screen 400 displayed on the communication terminal 30A on which the video including the wide-view image distributed in real time is being displayed. In an embodiment, in response to the user b giving an instruction to share a wide-view image captured in accordance with a recording request, the download button 402 is displayed on the communication terminal 30A of a participant who is in the same virtual room. Accordingly, an imaging operator who has provided a recording instruction (i.e., the user b) can view a recorded image at hand and then share the recorded image with other participants. As a result, a wide-view image recorded in error or a wide-view image not to be shared can be prevented from being shared. All of the communication terminals 30 that have entered the virtual room may automatically display the download button 402 in response to the storage of a wide-view image.

In the following description with reference to FIGS. 31A and 31B, the communication terminal 30A displays the download button 402. FIG. 31A illustrates an example of an image viewing screen 410 displayed before the user a presses the download button 402. Before the user a presses the download button 402, the communication terminal 30A displays, in the first image field 211, a wide-view image captured at an angle of view such that the wide-view image includes, for example, a working machine with a drill, as a virtual point of view designated by the user a. During the display of the wide-view image, the user a presses the download button 402.

FIG. 31B illustrates an example of an image viewing screen 420 displayed on the user a side after the user a presses the download button 402. The wide-view image associated with the point-of-view information obtained when the user b presses the recording button 401 is displayed in the first image field 211 illustrated in FIG. 29. Thus, as illustrated in FIG. 31B, a downloaded recorded wide-view image with the same point of view as that in the first image field 211 illustrated in FIG. 29 is displayed in the first image field 211 on the communication terminal 30A. Accordingly, a recorded wide-view image captured at an angle of view such that a scene of a crane on the rooftop of a building lifting up building material is visible is displayed instead of the wide-view image including the working machine with the drill. The user a can also change, as desired, the virtual point of view for the downloaded wide-view image displayed in the first image field 211 illustrated in FIG. 31B in a manner similar to that for the video including the wide-view image distributed in real time. As a result, the wide-view image of a specific scene can also reflect, as an initial value, the point of view of the user who has made the recording request. In addition, a specific scene of the on-site situation that is difficult to view at a normal angle of view is also visible.

As described above, users at different sites can share a virtual point of view for a recorded wide-view image of a specific scene at a later time. The wide-view image stored in response to a storage request may be displayed as a pop-up, instead of being displayed in the first image field 211 illustrated in FIG. 31B, or may be displayed in a separate window. This allows the users to view the on-site situation, which changes over time, by using the video including the wide-view image video distributed in real time and also to efficiently communicate with each other by using the recorded wide-view image of the specific scene.

As illustrated in FIG. 31B, the recording button 401 is not displayed during the display of the wide-view image downloaded by the communication terminal 30A. This is because

no real-time wide-view image is displayed in the first image field **211**. The device name **214** in the first image field **211** indicates the name of the image capturing apparatus **10** and also indicates a shared image. The device name **214** may be identified by the information on the tenant-registered device stored in the tenant information storage unit **5003**. In an example, the device name **214** is a device ID.

The users a and b can delete the download button **402**, as desired, after the download button **402** is displayed on the communication terminals **30**A and **30**B, respectively.

As illustrated in FIG. **32**, the communication terminals **30**A and **30**B may further display a thumbnail image **404** of the wide-view image in addition to (or in place of) the download button **402**. The thumbnail image **404** may be created by the information processing system **50** or the communication terminal **30**. The point of view for the thumbnail image **404** is defined by the point-of-view information.

Each of the users a and b preferably can set a data name for a wide-view image recorded in response to a recording request. The data name is registered in the image management information storage unit **3001** of each communication terminal **30**.

FIG. **33** illustrates an example of an image viewing screen **430** including three image fields. The image viewing screen **430** illustrated in FIG. **33** includes a first image field **211**, a second image field **212**, and a third image field **431**. In an example, the first image field **211** is for displaying a wide-view image captured by the image capturing apparatus **10**, the second image field **212** is for displaying an image having a normal angle of view captured by the camera **9** of the communication terminal **30**A, and the third image field **431** is for displaying an image having a normal angle of view captured by the camera **8** of the communication terminal **30**C. Any one of the users a, b, and c can press the recording button **401**, and the users a, b, and c can share the wide-view image from the same point of view at the respective sites.

Operation or Process in Response to Recording Request in Sharing of Wide-View Image

Next, an operation or process of the communication system **1***a* in response to a recording request in the sharing of a wide-view image will be described with reference to FIG. **28**. FIG. **28** is a sequence diagram illustrating an example process in which the user b uses the communication terminal **30**B to issue a recording request in the sharing of a wide-view image. In FIG. **28**, the communication terminals **30**A and **30**B have entered the virtual room by executing the room entry process described with reference to FIG. **18**. In the example illustrated in FIG. **28**, the user b presses the recording button **401** to share the point-of-view information with the user a. In another example, the user a presses the recording button **401** to share the point-of-view information with the user b. In FIG. **28**, the image capturing apparatus **10** has already connected to the same virtual room in accordance with the registration procedure illustrated in FIG. **26**. In FIG. **28**, in an embodiment, each communication terminal **30** has installed therein a viewer application having a function related to display of a predetermined-area image and transmission of point-of-view information. In an example, the viewer application is not installed in advance, and each communication terminal **30** may have an equivalent function in advance. In another example, each communication terminal **30** may receive a program having a function equivalent to that of a viewer application from the information processing system **50** or any other server at the time of entry into the virtual room and perform the processes of the communication terminals **30**A and **30**B illustrated in FIG. **28**. The viewer application of the communication terminal **30** may be implemented by a web browser.

S**61**: The user b inputs an operation of pressing the recording button **401** illustrated in FIG. **29**. The acceptance unit **32** of the communication terminal **30**B accepts the input operation of pressing the recording button **401**. The pressing of the recording button **401** is an example of an operation input method for transmitting a recording request. In another example, a recording request is transmitted in response to an input to another user interface. Examples of the user interface include a GUI, a voice-based interface, and a gesture-based interface.

S**62**: In response to receipt of an operation input for transmitting a recording request, the communication unit **31** of the communication terminal **30**B transmits a recording request to the information processing system **50**. The recording request includes a virtual room ID for identifying a virtual room that is currently being used, and an image capturing apparatus ID for identifying an image capturing apparatus from which the video is distributed. Then, the communication unit **51** of the information processing system **50** receives the recording request. While both an image and audio are recorded, recording of an image will be described below for simplicity. In this embodiment, audio is also recorded in a manner similar to that of an image, and audio data is also communicated in a manner similar to that for image data.

S**63**: In response to the communication unit **51** of the information processing system **50** receiving the recording request, the association processing unit **53** refers to the virtual room information storage unit **5002** to create storage location information (e.g., URL) of the wide-view image recorded based on the virtual room ID. Further, the association processing unit **53** identifies the communication terminal **30**A in the virtual room and creates storage location information (e.g., URL) of point-of-view information directed to the storage **90** set in the same virtual room. Then, the communication unit **51** transmits an instruction to start uploading the point-of-view information to the communication terminal **30**A. The instruction to start uploading the point-of-view information includes a point-of-view information storage URL dedicated to the communication terminal **30**A. Then, the communication unit **31** of the communication terminal **30**A receives the instruction. In response to the instruction, the display control unit **33** displays the download button **402**.

S**64**: The communication unit **51** of the information processing system **50** transmits, to the communication terminal **30**B from which the recording request is transmitted, an instruction to start uploading the point-of-view information (including storage location information of the point-of-view information), as in the transmission to the communication terminal **30**A, and transmits a recording start instruction as a response to the recording request. The recording start instruction includes storage location information of the recorded wide-view image.

S**65**: The recording unit **35** of the communication terminal **30**B starts recording a wide-view image (see step S**46**) related to a moving image distributed from the image capturing apparatus **10** and recording audio. The recorded image data is temporarily stored in the storage unit **3000** from the recording unit **35** via the storing/reading unit **39**. In an example, the image data includes audio data. The recording unit **35** also records audio.

S**66**: The user b uses the pointing device **312**, an external mouse, or the like to input an operation of shifting (changing) the virtual point of view for a default predetermined-

area image displayed on the communication terminal **30**B. Then, the acceptance unit **32** accepts the operation of shifting the point of view. The display control unit **33** displays, on the display **306** of the communication terminal **30**B, a predetermined-area image corresponding to a new point of view after changing. In an example, the predetermined-area image displayed by default is illustrated in FIG. **10**B. The point of view of the virtual camera IC is shifted in the manner as illustrated in FIG. **10**C in response to an operation by the user b. As a result, the predetermined-area image illustrated in FIG. **10**D is displayed on the display **306**. In an example, the virtual point of view may be shifted by an input to a user interface such as the pointing device **312**. In another example, the virtual point of view may be shifted by an audio input or a gesture input.

S**67**: The communication unit **31** of the communication terminal **30**B uploads the point-of-view information and point-of-view related information to the information processing system **50** in accordance with the point-of-view shifting operation. The point-of-view information is information for identifying a predetermined area in the wide-view image for a point of view obtained by shifting the virtual point of view. The point-of-view related information includes, as illustrated in FIG. **16**, the data ID of the wide-view image to be recorded, the user ID of the user b, who is a participant, viewing start date and time information indicating the date and time when the virtual point of view was shifted and the viewing of the new predetermined-area image was started, and the storage location information of the point-of-view information acquired in step S**64**. Then, the communication unit **51** of the information processing system **50** receives the point-of-view related information. The storing/reading unit **59** stores the point-of-view related information in the point-of-view related information storage unit **5004** as one record.

S**68**: The communication unit **51** of the information processing system **50** stores the point-of-view information received in step S**67** in the storage location (such as URL) specified in the storage location information of the point-of-view information received in step S**67**. In an example, the information processing system **50** does not store the point-of-view information in the storage **90**. The information processing system **50** may store the point-of-view information in the point-of-view related information illustrated in FIG. **16**, in place of the "storage location information of the point-of-view information" in the point-of-view related information.

S**69**: The user a performs an operation similar to that of the user b in step S**66**.

S**70**: As in step S**67**, the communication unit **31** of the communication terminal **30**A uploads the point-of-view information and the point-of-view related information to the information processing system **50**.

S**71**: As in step S**68**, the communication unit **51** of the information processing system **50** stores the point-of-view information received in step S**70** in the storage location (such as URL) specified in the storage location information of the point-of-view information received in step S**70**.

S**72**: In response to the user b inputting an operation of stopping recording by using the mouse or the like, the acceptance unit **32** accepts the recording stop operation.

S**73**: In response to receipt of the input of the recording stop operation, the recording unit **35** stops the recording operation.

S**74**: In the communication terminal **30**B, the storing/reading unit **39** reads the recorded image data stored in the storage unit **3000**. The communication unit **31** uploads and stores the recorded image data of the wide-view image related to the moving image to the storage location in the storage **90** specified in the storage location information of the wide-view image acquired in step S**64**. In step S**74**, the recorded data may be uploaded to and stored in the storage location in the storage **90** via the information processing system **50**.

S**75**: If the upload is completed in step S**74**, the communication unit **31** of the communication terminal **30**B notifies the information processing system **50** of the completion of the upload of the recorded image data.

S**76-1** and S**76-2**: In response to receipt of the notification indicating that the upload is completed, the communication unit **51** of the information processing system **50** notifies the communication terminal **30**A and the communication terminal **30**B, which are in the virtual room, of the storage location information (such as URL) of the wide-view image. Upon receipt of the notification, the display control units **33** of the communication terminals **30**A and **30**B can display the download button **402**, which has been described with reference to FIGS. **31** and **30**, respectively. In response to the acceptance unit **32** accepting an operation input corresponding to the pressing of the download button **402**, the communication unit **31** of each of the communication terminals **30**A and **30**B requests the storage **90** for the recorded image data stored in the storage location in the storage **90** specified in the storage location information and downloads the recorded image data from the storage **90** to share the recorded image data. The communication unit **31** of each of the communication terminals **30**A and **30**B may transmit a request for the recorded image data to the storage **90** via the information processing system **50**. The communication unit **31** of each of the communication terminals **30**A and **30**B may download the recorded image data from the storage **90** via the information processing system **50**.

Then, the process illustrated in FIG. **28** ends.

When the communication terminal **30** is implemented as the smart glasses **88** or the VR goggles **89**, the process illustrated in FIG. **28** is executed in a similar way.

FIG. **34** illustrates a modification of the process illustrated in FIG. **28**. FIG. **34** is a sequence diagram illustrating another process for uploading the point-of-view information and the wide-view image. Also in the modification, since processing similar to that in steps S**61** to S**65** in FIG. **28** is performed, the description thereof will be omitted. The processing after recording is started in the communication terminal **30**B will be described from step S**86**.

S**86**: As in step S**66** described above, the user b uses the pointing device **312**, an external mouse, or the like to input an operation of shifting (changing) the virtual point of view for a default predetermined-area image displayed on the communication terminal **30**B. Then, the acceptance unit **32** of the communication terminal **30**B accepts the operation of shifting the point of view. The display control unit **33** displays, on the display **306** of the communication terminal **30**B, a predetermined-area image corresponding to a new point of view after changing.

S**87**: In the communication terminal **30**B, the storing/reading unit **39** stores, in the storage unit **3000**, point-of-view information for identifying a predetermined area for a point of view obtained by shifting the virtual point of view in step S**86**, and point-of-view related information related to the point-of-view information.

S**88**: As in step S**86**, the user a also uses the pointing device **312**, an external mouse, or the like to input an operation of shifting (changing) the virtual point of view for a default predetermined-area image displayed on the com-

munication terminal **30**A. Then, the acceptance unit **32** of the communication terminal **30**A accepts the operation of shifting the point of view. The display control unit **33** displays, on the display **306** of the communication terminal **30**A, a predetermined-area image corresponding to a new point of view after changing.

S**89**: Also in the communication terminal **30**A, as in step S**87**, the storing/reading unit **39** stores, in the storage unit **3000**, point-of-view information for identifying a predetermined area for a point of view obtained by shifting the virtual point of view in step S**88**, and point-of-view related information related to the point-of-view information.

S**90**: In response to the user b stopping recording by using the mouse or the like, as in step S**72**, the acceptance unit **32** accepts the recording stop operation.

S**91**: The recording unit **35** stops the recording operation.

S**92**: The communication unit **31** of the communication terminal **30**B transmits, to the information processing system **50**, a recording stop notification indicating that the recording operation has been stopped. Then, the communication unit **51** of the information processing system **50** receives the recording stop notification.

S**93**: The communication unit **51** of the information processing system **50** transmits an upload request to the communication terminal **30**A, which has not performed the recording process, to upload the point-of-view information and the point-of-view related information. Then, the communication unit **31** of the communication terminal **30**A receives the upload request.

S**94**: In the communication terminal **30**B, the storing/reading unit **39** reads the recorded image data of the wide-view image, the point-of-view information, and the point-of-view related information, which are stored in the storage unit **3000**. The communication unit **31** uploads the recorded image data of the wide-view image, the point-of-view information, and the point-of-view related information to the information processing system **50**. As described above, the point-of-view related information includes storage location information of the point-of-view information. Then, the communication unit **51** of the information processing system **50** receives the recorded image data of the wide-view image, the point-of-view information, and the point-of-view related information.

S**95**: The communication unit **51** of the information processing system **50** stores the point-of-view information received in step S**94** in the storage location (such as URL) specified in the storage location information of the point-of-view information received in step S**94**. Further, the communication unit **51** of the information processing system **50** stores the recorded image data of the wide-view image received in step S**94** in the storage location (such as URL) in the storage **90** specified in the storage location information of the wide-view image stored in the image management information storage unit **5001** (see FIG. **14**A or **14**B). If the communication terminal **30**B can identify the storage location, the communication terminal **30**B may store the recorded image data of the wide-view image and the point-of-view information directly in the storage **90** without the intervention of the information processing system **50**.

S**96**: In the communication terminal **30**A, the storing/reading unit **39** reads the point-of-view information and the point-of-view related information, which are stored in the storage unit **3000**. The communication unit **31** transmits the point-of-view information and the point-of-view related information to the information processing system **50**. As described above, the point-of-view related information includes storage location information of the point-of-view information. Then, the communication unit **51** of the information processing system **50** receives the point-of-view information and the point-of-view related information.

S**97**: The communication unit **51** of the information processing system **50** stores the point-of-view information received in step S**96** in the storage location (such as URL) in the storage **90** specified in the storage location information of the point-of-view information received in step S**96**. Further, the communication unit **51** of the information processing system **50** stores the recorded image data of the wide-view image received in step S**94** in the storage location (such as URL) in the storage **90** specified in the storage location information of the wide-view image stored in the image management information storage unit **5001** (see FIG. **14**A or **14**B). If the communication terminal **30**A can identify the storage location, the communication terminal **30**A may store the point-of-view information directly in the storage **90** without the intervention of the information processing system **50**.

S**98-1** and S**98-2**: Upon completion of the storage of the recorded image data and the point-of-view information in the storage **90** as a result of execution of the processing described in steps S**95** and S**97**, the communication unit **51** of the information processing system **50** notifies the communication terminal **30**A and the communication terminal **30**B, which are in the virtual room, of the storage location information (such as URL) of the wide-view image. Upon receipt of the notification, the display control units **33** of the communication terminals **30**A and **30**B can display the download button **402**, which has been described with reference to FIGS. **31** and **30**, respectively. In response to the acceptance unit **32** accepting an operation input corresponding to the pressing of the download button **402**, the communication unit **31** of each of the communication terminals **30**A and **30**B requests the storage **90** for the recorded image data stored in the storage location in the storage **90** specified in the storage location information and downloads the recorded image data from the storage **90** to share the recorded image data. The communication unit **31** of each of the communication terminals **30**A and **30**B may transmit a request for the recorded image data to the storage **90** via the information processing system **50**. The communication unit **31** of each of the communication terminals **30**A and **30**B may download the recorded image data from the storage **90** via the information processing system **50**.

Then, the process illustrated in FIG. **34** ends.

In the examples illustrated in FIGS. **28** and **34**, the communication terminal **30** starts and stops recording. As described with reference to FIG. **27**, the information processing system **50** also receives the wide-view image captured by the image capturing apparatus **10** in a manner similar to that of the communication terminal **30**. In an example, the information processing system **50** includes a recording unit that is similar to the recording unit **35** of the communication terminal **30**. The recording unit of the information processing system **50** may start and stop recording the wide-view image. In this case, a server such as a cloud server records the wide-view image. This configuration has the advantage of no processing load on the communication terminal **30** operated by the user for recording. In this modification, the communication terminal **30** uploads the recorded image data in step S**74**, and the recorded image data is stored in the storage **90** by the information processing system **50**.

In an example, the image capturing apparatus **10** has the function of the recording unit **35**. The image capturing apparatus **10** may record a wide-view image. This configu-

ration has the advantage of no processing load on the information processing system **50** or the communication terminal **30** for recording. In this modification, in response to the information processing system **50** receiving a recording request in step S**62**, the information processing system **50** transmits the recording request to the image capturing apparatus **10** corresponding to the image capturing apparatus ID. Accordingly, the image capturing apparatus **10** can start recording. In response to receipt of an input of a recording stop operation in step S**72**, the communication terminal **30** transmits a recording stop request to the information processing system **50**. The information processing system **50** further transmits, to the image capturing apparatus **10**, a recording stop request including the storage location information. Accordingly, the image capturing apparatus **10** can stop recording. After the recording operation is stopped, as in step S**74**, the image capturing apparatus **10**, rather than the communication terminal **30**, uploads the recorded image data to the storage **90** (or via the information processing system **50**) in accordance with the storage location information.

In the examples illustrated in FIGS. **28** and **34**, the communication terminal **30** that has transmitted a recording request among the communication terminals **30** performs recording. In an example, in response to receipt of an instruction to start uploading point-of-view information, all of the communication terminals **30** in the virtual room may perform control to start or stop recording of the wide-view image being distributed, in a manner similar to that of the communication terminal **30** that has transmitted the recording request, and may upload recorded image data of the wide-view image.

In the examples illustrated in FIGS. **28** and **34**, in an example, the point-of-view information is in a data format in which the point-of-view information is embedded in the recorded image data. The point-of-view information may be transmitted to the information processing system **50** or the storage **90** by transmission of the recorded image data including the point-of-view information.

Viewing of Current Image and Previous Image

Next, a process in which the user views a current image and a previous image that is stored in the storage **90** will be described with reference to FIGS. **35** to **37**. FIG. **35** is a sequence diagram illustrating a process in which the user views a current image and a previous image that is stored in the storage **90** FIG. **36** is a view illustrating an example of an image viewing screen for selecting a previous image during display of a current predetermined-area image. FIG. **37** is a view illustrating an example of an image viewing screen for displaying a previous predetermined-area image having the same virtual point of view as the current predetermined-area image during display of the current predetermined-area image. The process illustrated in FIG. **35** is performed after any user has already logged in. FIGS. **36** and **37** illustrate a modification of the image viewing screen **210** illustrated in FIG. **17**B. The viewer application described above has been installed in the communication terminal **30**. In FIG. **35**, the communication terminal **30** is an example of a display terminal.

S**301**: The storing/reading unit **59** of the information processing system **50** searches the image management information storage unit **5001** (see FIG. **14**A or **14**B) and reads previous-image specifying information. The previous-image specifying information is contained in a record having the same data name (or imaging-time virtual room ID) of a current wide-view image that is currently distributed. The current wide-view image is a live image. The previous-image specifying information is information for specifying a previously recorded wide-view image. The previous-image specifying information includes at least the data ID of the wide-view image. In one example, the previous-image specifying information includes the data ID of the wide-view image, imaging start date and time information, and imaging end date and time information.

S**302**: The communication unit **51** of the information processing system **50** distributes the current wide-view image, which is a live image, and the previous-image specifying information searched for in step S**301**. Then, the communication unit **31** of the communication terminal **30** receives the current wide-view image and the previous-image specifying information.

S**303**: In the communication terminal **30**, as illustrated in FIG. **36**, the display control unit **33** causes the display **306** to display an image viewing screen **210***a*. The image viewing screen **210***a* is basically similar to the image viewing screen **210** illustrated in FIG. **17**B and includes a first image field **211** and a second image field **411**. In FIG. **36**, the same components as those in FIG. **17**B are denoted by the same reference numerals, and will not be described.

The first image field **211** displays a predetermined-area image (an example of a first predetermined-area image) that represents a predetermined area in the current wide-view image. The second image field **411** displays a pull-down menu pm for selecting previous-image specifying information. The second image field **411** also displays a "Play" button **412** for playing back an image specified in the previous-image specifying information selected in the pull-down menu pm. The previous-image specifying information may be displayed in a display form other than the pull-down menu pm.

S**304**: In response to the user selecting predetermined previous-image specifying information in the pull-down menu pm and pressing the "Play" button **412**, the acceptance unit **32** accepts the selection of the predetermined previous-image specifying information.

S**305**: The communication unit **31** of the communication terminal **30** transmits a request for storage location information of a wide-view image specified in the previous-image specifying information selected in step S**304**. The request includes the data ID of the wide-view image related to the predetermined previous-image specifying information. Then, the communication unit **51** of the information processing system **50** receives the request for the storage location information of the wide-view image.

S**306**: In the information processing system **50**, the storing/reading unit **59** searches the image management information storage unit **5001** (see FIG. **14**A or **14**B) by using the data ID of the wide-view image received in step S**305** as a search key and reads the corresponding storage location information.

S**307**: The communication unit **51** of the information processing system **50** transmits the storage location information read in step S**306** to the communication terminal **30**. Then, the communication unit **31** of the communication terminal **30** receives the storage location information.

S**308**: The communication unit **31** of the communication terminal **30** accesses the storage location (such as URL) indicated by the storage location information received in step S**307**.

S**309**: The communication unit **31** of the communication terminal **30** acquires (or downloads) a previous wide-view image from the storage location accessed in step S**308**.

S**310**: In the communication terminal **30**, as illustrated in FIG. **37**, the display control unit **33** displays a predeter-

mined-area image in the second image field **411**. The predetermined-area image represents a predetermined area in the previous wide-view image acquired in step S**309**. In this case, the display control unit **33** uses point-of-view information used to display the predetermined-area image displayed in the first image field **211** to display a predetermined-area image of a predetermined area specified at the same point of view as that of the predetermined-area image displayed in the first image field **211**. The second image field **411** displays a device name **414** and a wide-view image mark **413**. The device name **414** specifies "(recording)". Like the wide-view image mark **213**, the wide-view image mark **413** is a mark indicating that the previous wide-view image (predetermined-area image) displayed in the second image field **411** is an image for which the point of view can be changed.

Desirably, the image capturing apparatus **10** that generates the image displayed in the first image field **211** and the image capturing apparatus **10** that generates the image displayed in the second image field **411** are basically placed in the same given location. The image capturing apparatuses **10** are not necessarily placed at exactly the same position in the given location. In one example, the image capturing apparatus **10** that generates the image displayed in the first image field **211** and the image capturing apparatus **10** that generates the image displayed in the second image field **411** are placed at positions within a predetermined distance (e.g., 1 m).

In FIG. **37**, the first image field **211** and the second image field **411** are simultaneously displayed in parallel, by way of example but not limitation. In another example, the first image field **211** and the second image field **411** are not displayed in a size larger than the display size illustrated in FIG. **37**, but are switched and displayed. Alternatively, the first image field **211** and the second image field **411** may be displayed in the same size as in FIG. **37** or in different sizes. For example, the second image field **411** may be displayed in a smaller size than the first image field **211**.

In FIG. **37**, the display control unit **33** displays a single second image field **411**. In another example, the display control unit **33** displays a plurality of second image fields **411**. In this example, in step S**304**, the user selects a plurality of items of previous-image specifying information. In step S**307**, a plurality of items of storage location information are transmitted. In step S**308**, a plurality of storage locations are accessed. In step S**309**, a plurality of wide-view images are acquired. In another example, the display control unit **33** may display respective predetermined-area images corresponding to a plurality of previous wide-view images without displaying a predetermined-area image corresponding to the current wide-view image.

S**311**: In response to the user performing an operation of shifting (or changing) the virtual point of view by using the mouse or the like in the first image field **211** illustrated in FIG. **37**, the acceptance unit **32** accepts the input of the operation. The shift of the virtual point of view indicates the change of the predetermined area T, that is, the shift from FIG. **10**A to FIG. **10**C.

S**312**: The display control unit **33** uses the point-of-view information related to a point of view obtained by changing the virtual point of view in step S**311** to change and display the previous predetermined-area image being displayed in the second image field **411** such that the point of view for the previous predetermined-area image matches the obtained point of view. As described above, a current wide-view image and a previous wide-view image are displayed in such a manner that predetermined-area images of the same point of view (or predetermined area) are displayed. This allows the user to easily compare the two images.

The point of view in the second image field **411** may be changed such that the point of view in the first image field **211** matches a point of view obtained by changing the point of view. Also in this case, the point-of-view information for specifying the predetermined-area image displayed in the second image field **411** is used to display the predetermined-area image displayed in the first image field **211**.

Then, the process illustrated in FIG. **35** ends.

Application Example of Communication System in Telemedicine

FIG. **38** is a diagram illustrating an example of remote communication using a communication system in telemedicine. A communication system **1***b* according to an embodiment of the present disclosure will be described with reference to FIG. **38**, with focus on differences from FIG. **1**.

In FIG. **38**, the site A is an operating room. The processing steps (**1**) to (**6**) in FIG. **38** are similar to those in FIG. **1**. In FIG. **38**, a patient is placed on an operating table **355** and is subjected to surgery by a medical professional such as a surgeon. The medical professional (corresponding to the user) operates on the patient with various surgical tools **354** such as forceps and a scalpel. The medical professional may wear the smart glasses **88** and transmit an image of the surgical field for surgery performed by the medical professional to the communication network N. Various cameras are placed in the operating room as image capturing apparatuses similar to the image capturing apparatus **10**. The cameras include a surgical camera **351**, a surgical field camera **352**, and an endoscope **353**. The image capturing apparatuses may have a function of capturing an image for generating a wide-view image. In an example, all of the image capturing apparatuses in the operating room and the smart glasses **88** are associated with a virtual room.

A main unit **356** is installed in the operating room. The main unit **356** monitors the vitals of a patient, the operating state of medical devices, and the like. The main unit **356** corresponds to the communication terminal **30** according to this embodiment. The communication terminal **30** (i.e., the main unit **356**) in the operating room may have a function of receiving video from the endoscope **353** or the surgical field camera **352** in addition to the functions illustrated in FIG. **1**. The communication terminal **30** can display the received video, including a wide-view image, on displays **306** and transmit the received video to the information processing system **50** as video of the site at which the communication terminal **30** is located. An operation panel **357** is an input interface that accepts various operations. In an example, a medical professional can operate a device in the operating room via the operation panel **357**. The endoscope **353**, the surgical camera **351**, and the surgical field camera **352** may communicate with the information processing system **50** directly without the intervention of the communication terminal **30**. As described above, since a plurality of image capturing apparatuses **10** can be associated with the same virtual room, a user at a remote site can make a request to record wide-view images of various on-site scenes at the site A. In an example, a user who desires to record captured video of the inside of the patient's body transmits a request to an image capturing apparatus corresponding to the endoscope **353** to record an image captured by the image capturing apparatus. In another example, a user who desires to record an image of the entire operating room transmits a request to an image capturing apparatus corresponding to the surgical camera **351** to record an image captured by the image capturing apparatus.

The communication terminal **30** may have the function of an electronic medical record system or the function of communicating with an electronic medical record system. The communication terminal **30** may display information on an electronic medical record on the display **306**. The storage **90** may be an electronic medical record system. In this case, recorded image data of a wide-view image recorded in response to a recording request (and point-of-view information associated with the wide-view image) may be stored by the association processing unit **53** in association with the electronic medical record of the patient. Folders indicated by storage locations of the storage **90** may be classified according to patient or surgery. The virtual room information storage unit **5002** may store information indicating a patient or the details of surgery in association with each other. As a result, information related to the patient or the surgery can be continuously displayed on a viewing screen of the communication terminal **30**.

FIG. **39** is a view illustrating an image viewing screen **210***b* for use in telemedicine for displaying a previous predetermined-area image having the same point of view as a current predetermined-area image during display of the current predetermined-area image. As illustrated in FIG. **39**, in the communication terminal **30**, the display control unit **33** displays, in the second image field **411**, a predetermined-area image that represents a predetermined area in a previous wide-view image. In this case, the display control unit **33** uses point-of-view information used to display the predetermined-area image displayed in the first image field **211** to display a predetermined-area image of a predetermined area having the same point of view as the predetermined-area image displayed in the first image field **211**. This facilitates comparison of the state of the same surgical site between the current and previous images.

As described above, the communication system according to this embodiment displays a plurality of wide-view images that are captured images of substantially the same location and captured at different times such that the respective predetermined areas in the wide-view images are taken into account, thereby providing an effect of displaying the wide-view images in such a manner that a user can easily compare the wide-view images.

While the present disclosure has been described using some embodiments, the embodiments do not limit the present disclosure in any way. Various modifications and replacements may be made within a scope not departing from the gist of the present disclosure.

In the example configurations illustrated in FIG. **13** and the like, the information processing system **50**, the image capturing apparatus **10**, and the communication terminal **30** are each divided according to main functions to facilitate understanding of the processes performed by the information processing system **50**, the image capturing apparatus **10**, and the communication terminal **30**. No limitation is intended by how the processes are divided into units or by the name of the units. The processes of the information processing system **50**, the image capturing apparatus **10**, and the communication terminal **30** may be divided into more units of processing in accordance with the content of the processes. Further, the division may be made such that each unit of processing includes more processing operations.

Each of the functions in the embodiments described above may be implemented by one or more processing circuits or circuitry. As used herein, the term "processing circuit or circuitry" is used to include a processor programmed to implement each function by software, such as a processor implemented by an electronic circuit, and devices designed to implement the functions described above, such as an application specific integrated circuit (ASIC), a digital signal processor (DSP), a field programmable gate array (FPGA), and existing circuit modules.

The apparatuses or devices described in one or more embodiments are just one example of plural computing environments that implement the one or more embodiments disclosed herein. In some embodiments, the information processing system **50** includes multiple computing devices, such as a server cluster. The multiple computing devices are configured to communicate with one another through any type of communication link, including a network, a shared memory, etc., and perform the processes disclosed herein.

Further, the information processing system **50** can be configured to share the processing steps disclosed herein, for example, the processing steps illustrated in FIGS. **26**, **27**, **28**, and **34**, in various combinations. For example, a process executed by a predetermined unit may be executed by a plurality of information processing apparatuses included in the information processing system **50**. The components of the information processing system **50** may be integrated into one server apparatus or divided into a plurality of apparatuses.

The above-described embodiments are illustrative and do not limit the present invention. Thus, numerous additional modifications and variations are possible in light of the above teachings. For example, elements and/or features of different illustrative embodiments may be combined with each other and/or substituted for each other within the scope of the present invention. Any one of the above-described operations may be performed in various other ways, for example, in an order different from the one described above.

According to Aspect 1, a display terminal for displaying a wide-view image on a display screen includes a display control unit. The display control unit displays, on the display screen, a first predetermined-area image representing a predetermined area in a first wide-view image that is a captured image of a given location and captured on a first date and time, and displays, on the display screen, a second predetermined-area image related to the predetermined area in a second wide-view image that is a captured image of the given location and captured on a second date and time different from the first date and time.

According to Aspect 2, the display terminal of Aspect 1 further includes an acceptance unit. The acceptance unit receives a shift of a virtual point of view for the first predetermined-area image displayed on the display screen. The display control unit changes and displays the second predetermined-area image in accordance with the predetermined area that is changed in response to the shift of the virtual point of view, received at the acceptance unit.

According to Aspect 3, the display terminal of Aspect 1 further includes an acceptance unit. The acceptance unit receives a shift of a virtual point of view for the displayed second predetermined-area image displayed on the display screen. The display control unit changes and displays the first predetermined-area image in accordance with the predetermined area that is changed in response to the shift of the virtual point of view, received at the acceptance unit.

According to Aspect 4, in the display terminal of any one of Aspects 1 to 3, the first wide-view image that is a captured image of the given location and captured on the first date and time and the second wide-view image that is a captured image of the given location and captured on the second date and time are captured images of a same position or positions within a predetermined distance.

According to Aspect 5, in the display terminal of any one of Aspects 1 to 3, the first wide-view image is a currently captured image, and the second wide-view image is a recorded previous image.

According to Aspect 6, in the display terminal of any one of Aspects 1 to 3, the first wide-view image and the second wide-view image are recorded previous images.

According to Aspect 7, a communication system includes an information processing system and a display terminal. The information processing system distributes a wide-area image. The display terminal receives and displays the distributed wide-area image. The information processing system distributes a first wide-view image and a second wide-view image. The first wide-view image and the second wide-view image are captured images of a given location and captured on different dates and times. The display terminal displays, on a display screen, a first predetermined-area image representing a predetermined area in the first wide-view image and a second predetermined-area image related to the predetermined area in the second wide-view image.

According to Aspect 8, a display method is executed by a display terminal that displays a wide-area image on a display screen. The display method includes displaying, on the display screen, a first predetermined-area image representing a predetermined area in a first wide-view image that is a captured image of a given location and captured on a first date and time; and displaying, on the display screen, a second predetermined-area image related to the predetermined area in a second wide-view image that is a captured image of the given location and captured on a second date and time different from the first date and time.

According to Aspect 9, a communication method is executed by a communication system including an information processing system that distributes a wide-area image, and a display terminal that receives and displays the distributed wide-area image. The communication method includes distributing, by the information processing system, a first wide-view image and a second wide-view image, the first wide-view image and the second wide-view image being captured images of a given location and captured on different dates and times; with the display terminal, displaying on a display screen a first predetermined-area image representing a predetermined area in the first wide-view image; and with the display terminal, displaying on the display screen a second predetermined-area image related to the predetermined area in the second wide-view image.

According to Aspect 10, a program causes a computer to execute a display method of displaying a wide-area image on a display screen. The display method includes displaying, on the display screen, a first predetermined-area image representing a predetermined area in a first wide-view image that is a captured image of a given location and captured on a first date and time; and displaying, on the display screen, a second predetermined-area image related to the predetermined area in a second wide-view image that is a captured image of the given location and captured on a second date and time different from the first date and time.

The invention claimed is:

1. A display terminal, comprising:

circuitry configured to:

display a first area image on a display screen, the first area image representing an area in a first wide-view image having been captured at a location on a first date and at a first time;

specify the area in a second wide-view image using point-of-view information used to display the first area image, the second wide-view image having been captured at the location on a second date and at a second time different from the first date and the first time; and

display a second area image on the display screen, the second area image being related to the specified area in the second wide-view image.

2. The display terminal according to claim **1**, wherein the circuitry is further configured to:

receive a shift of a virtual point of view for the first area image displayed on the display screen; and

change a display of the second area image in accordance with a change in the area, the change in the area being made based on the shift of the virtual point of view received for the first area image.

3. The display terminal according to claim **1**, wherein the circuitry is further configured to:

receive a shift of a virtual point of view for the second area image displayed on the display screen, and

change a display of the first area image in accordance with a change in the area, the change in the area being made based on the shift of the virtual point of view received for the second area image.

4. The display terminal according to claim **1**, wherein the first wide-view image and the second wide-view image were captured are a same position or positions within a predetermined distance.

5. The display terminal according to claim **1**, wherein the first wide-view image is a currently captured image, and the second wide-view image is a recorded previous image.

6. The display terminal according to claim **1**, wherein the first wide-view image and the second wide-view image are recorded previous images.

7. A communication system, comprising:

an information processing system to distribute a wide-view image; and

a display terminal to receive and display the wide-view image, wherein

the information processing system includes first circuitry configured to distribute a first wide-view image and a second wide-view image, the first wide-view image and the second wide-view image having been captured at a location on different dates and at different times, and

the display terminal includes second circuitry configured to:

display a first area image on a display screen, the first area image representing an area in the first wide-view image;

specify the area in the second wide-view image using point-of-view information used to display the first area image, the second wide-view image having been captured at the location on a second date and at a second time different from the first date and the first time; and

display a second area image on the display screen, the second area image being related to the specified area in the second wide-view image.

8. A display method, comprising:

displaying a first area image on a display screen, the first area image representing an area in a first wide-view image having been captured at a location on a first date and time;

specifying the area in a second wide-view image using point-of-view information used to display the first area image, the second wide-view image having been captured at the location on a second date and at a second time different from the first date and the first time; and

displaying a second area image on the display screen, the second area image being related to the specified area in the second wide-view image.

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