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Communication terminal, image communication system, and method of displaying image

Abstract

A communication terminal including circuitry to: receive video data including a captured image, from a communication management server that manages the captured image of video data distributed from another communication terminal different from the communication terminal; determine whether any predetermined-area information indicating a predetermined area of the captured image to be displayed during a reproduction time of the video data is stored in a memory; and control a display to display an image representing the predetermined area indicated by the predetermined-area information, based on a determination that the predetermined-area information is stored in the memory.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation of U.S. application Ser. No. 17/831,462, filed Jun. 3, 2022, which is based on and claims priority pursuant to 35 U.S.C. § 119(a) to Japanese Patent Application No. 2021-094184, filed on Jun. 4, 2021, in the Japan Patent Office, the entire disclosure of each is hereby incorporated by reference herein.

BACKGROUND
Technical Field
(1) The present disclosure relates to a communication terminal, an image communication system, and a method of displaying image.
Description of the Related Art
(2) Some image capturing devices are capable of capturing images in all directions using a plurality of wide-angle lenses or fisheye lenses. Image data captured using such an image capturing device at a certain site may be used in a system, which distributes the captured image data in real time to another site, to allow a user at the other site to view an image being captured at the certain site where the image capturing device is installed.
(3) Further, an image capturing device capable of capturing a spherical panoramic image in real time is connectable to communication terminals, and a spherical panoramic image acquired by the image capturing device is transmitted to communication terminals connected to the image capturing device. Each communication terminal sequentially converts the received spherical panoramic image to a predetermined-area image representing a predetermined area, which is a part of the spherical panoramic image, and displays the predetermined-area image on a display. This enables a user at each of remote sites to determine, by himself or herself, a predetermined-area image to be displayed, representing an image of a predetermined area that the user is interested in, from a whole image of the spherical panoramic image.
(4) In the distribution of a spherical panoramic image, viewers are allowed to change their display directions as desired. This enables the viewers to view the spherical panoramic image from different display directions.
(5) In the existing method, however, in the distribution of video data, it is difficult to display an appropriate predetermined area on a communication terminal according to the demand of a

distributor or a viewer.

SUMMARY

(6) Example embodiments include a communication terminal including circuitry that: receives video data including a captured image, from a communication management server that manages the captured image of video data distributed from another communication terminal different from the communication terminal; determines whether any predetermined-area information indicating a predetermined area of the captured image to be displayed during a reproduction time of the video data is stored in a memory; and controls a display to display an image representing the predetermined area indicated by the predetermined-area information, based on a determination that the predetermined-area information is stored in the memory.

(7) Example embodiments include an image communication system including a communication terminal including terminal circuitry, and a communication management server including server circuitry. The server circuitry receives data of a captured image transmitted from another communication terminal different from the communication terminal, and stores video data including the captured image, and predetermined-area information indicating a predetermined area of the captured image to be displayed during a reproduction time of the video data. The terminal circuitry receives the video data including the captured image, from the communication management server, determines whether any predetermined-area information indicating a predetermined area of the captured image to be displayed during a reproduction time of the video data is present, and controls a display to display an image representing the predetermined area indicated by the predetermined-area information, based on a determination that the predetermined-area information is present.

(8) Example embodiments include a method of displaying an image, performed by a communication terminal, the method including: receiving video data including a captured image, from a communication management server being configured to manage the captured image of video data distributed from another communication terminal different from the communication terminal; determining whether any predetermined-area information indicating a predetermined area of the captured image to be displayed during a reproduction time of the video data is stored in a memory; and displaying on a display an image representing the predetermined area indicated by the predetermined-area information, based on a determination that the predetermined-area information is stored in the memory.

(9) Example embodiments include a non-transitory recording medium storing a plurality of instructions which, when executed by one or more processors, cause the processors to perform the above-described method.

Description

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

(1) A more complete appreciation of the 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:

(2) FIG. **1**A is a left side view of an image capturing device according to embodiments;

(3) FIG. **1**B is a front view of the image capturing device according to embodiments;

(4) FIG. **1**C is a plan view of the image capturing device according to embodiments;

(5) FIG. **2** is an illustration for explaining how a user uses the image capturing device, according to an embodiment;

(6) FIG. **3**A is a view illustrating a hemispherical image (front side) captured by the image capturing device, according to embodiments;

(7) FIG. **3**B is a view illustrating a hemispherical image (back side) captured by the image

capturing device, according to embodiments;

(8) FIG. **3**C is a view illustrating an image in equirectangular projection, according to embodiments;

(9) FIG. **4**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 embodiments;

(10) FIG. **4**B is a view illustrating a spherical image, according to embodiments;

(11) FIG. **5** is a view illustrating positions of a virtual camera and a predetermined area in a case in which the spherical image is represented as a three-dimensional solid sphere according to embodiments;

(12) FIG. **6**A is a perspective view of the spherical image illustrated in FIG. **5** according to embodiments;

(13) FIG. **6**B is a view illustrating an image of the predetermined area on a display, according to embodiments;

(14) FIG. **7** is a view illustrating a relation between predetermined-area information and the image of the predetermined area according to embodiments;

(15) FIG. **8** is a view illustrating points in a three-dimensional Euclidean space defined in spherical coordinates, according to embodiments;

(16) FIG. **9** is a diagram illustrating an example general arrangement of an image communication system according to embodiments;

(17) FIG. **10** is a diagram illustrating an example hardware configuration of the image capturing device according to embodiments;

(18) FIG. **11** is a diagram illustrating an example hardware configuration of a communication terminal and a communication management system according to embodiments;

(19) FIG. **12** is a diagram illustrating an example functional configuration of the image communication system according to embodiments;

(20) FIG. **13** is a diagram illustrating an example functional configuration of the image communication system according to embodiments;

(21) FIG. **14** is a conceptual view illustrating an example of an image type management table according to embodiments;

(22) FIG. **15** is a conceptual view illustrating an example of an image capturing device management table according to embodiments;

(23) FIG. **16** is a conceptual view illustrating an example of a predetermined-area management table according to embodiments;

(24) FIG. **17** is a conceptual view illustrating an example of a session management table according to embodiments;

(25) FIG. **18** is a conceptual view illustrating an example of an image type management table according to embodiments;

(26) FIG. **19** is a conceptual view illustrating an example of a video data management table according to embodiments;

(27) FIG. **20** is a conceptual view illustrating an example of a predetermined-area management table according to embodiments;

(28) FIG. **21** is a sequence diagram illustrating operation of processing a request for participation in a communication session, performed by the image communication system, according to embodiments;

(29) FIG. **22** is a diagram illustrating an example of a selection screen for selecting a session, according to embodiments;

(30) FIG. **23** is a sequence diagram illustrating operation of managing image type information, performed by the image communication system, according to embodiments;

(31) FIG. **24** is a sequence diagram illustrating operation of transmitting captured image data and audio data, performed by the image communication system, according to embodiments;

(32) FIG. **25** is a view illustrating an example of a display screen displayed on the communication terminal according to embodiments;

(33) FIG. **26** is a flowchart illustrating an example of a video data recording process according to embodiments;

(34) FIG. **27** is a sequence diagram illustrating an example of a distribution condition setting process according to embodiments;

(35) FIG. **28** is a view illustrating an example of a distribution condition setting screen according to embodiments;

(36) FIG. **29** is a sequence diagram illustrating an example of a recorded video data distribution process according to embodiments;

(37) FIG. **30** is a flowchart illustrating an example process for reproducing video data on the communication terminal according to embodiments;

(38) FIG. **31** is a view illustrating an example of a display screen displayed on the communication terminal when a synchronized display direction is provided, according to embodiments;

(39) FIG. **32** is a flowchart illustrating an example process for changing a display direction on the communication terminal according to embodiments; and

(40) FIG. **33** is a view illustrating an example of a display screen displayed on the communication terminal when no synchronized display direction is provided, according to embodiments.

(41) The accompanying drawings are intended to depict embodiments of the present invention 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

(42) 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.

(43) Embodiments of the present disclosure are described below with reference to the drawings. In the description of the drawings, the same elements are denoted by the same reference numerals, and redundant descriptions thereof are omitted.

(44) Method for Generating Spherical Image

(45) A method for generating a spherical image according to one or more embodiments is described with reference to FIGS. **1**A to **8**.

(46) First, referring to FIGS. **1**A to **1**C, an external view of an image capturing device **10** is described according to the embodiments. The image capturing device **10** is a digital camera for capturing images from which a 360-degree spherical image is generated. FIG. **1**A is a left side view of the image capturing device **10**. FIG. **1**B is a front view of the image capturing device **10**. FIG. **1**C is a plan view of the image capturing device **10**.

(47) As illustrated in FIG. **1**A, the image capturing device **10** has a shape such that a person can hold it with one hand. Further, as illustrated in FIGS. **1**A, **1**B, and **1**C, the image capturing device **10** includes an imaging element **103***a* and an imaging element **103***b* on its upper section. The imaging element **103***a* and the imaging element **103***b* are provided on a front side (anterior side) and a back side (rear side or posterior side) of the image capturing device **10**, respectively. These imaging elements (image sensors) **103***a* and **103***b* are used in combination with optical members (e.g., lenses **102***a* and **102***b*, described below), each being configured to capture a hemispherical image having an angle of view of 180 degrees or wider. As illustrated in FIG. **1**B, the image capturing device **10** further includes an operation unit **115** such as a shutter button on the rear side

of the image capturing device **10**, which is opposite to the front side of the image capturing device **10**.

(48) Next, referring to FIG. **2**, a description is given of a situation where the image capturing device **10** is used. FIG. **2** is an illustration for explaining how a user uses the image capturing device, according to embodiments. As illustrated in FIG. **2**, for example, the image capturing device **10** is used for capturing objects surrounding the user who is holding the image capturing device **10** in his or her hand. The imaging element **103***a* and the imaging element **103***b* illustrated in FIGS. **1**A to **1**C capture the objects surrounding the user to obtain two hemispherical images.

(49) Next, referring to FIGS. **3**A to **3**C and FIGS. **4**A and **4**B, a description is given of an overview of an operation of generating an equirectangular projection image EC and a spherical image CE from the images captured by the image capturing device **10**. FIG. **3**A is a view illustrating a hemispherical image (front side) captured by the image capturing device **10**. FIG. **3**B is a view illustrating a hemispherical image (back side) captured by the image capturing device **10**. FIG. **3**C is a view illustrating an image in equirectangular projection, which is referred to as an "equirectangular projection image" (or equidistant cylindrical projection image) EC. FIG. **4**A is a conceptual diagram illustrating an example of how the equirectangular projection image EC is mapped to a surface of a sphere CS. FIG. **4**B is a view illustrating the spherical image CE.

(50) As illustrated in FIG. **3**A, an image captured by the imaging element **103***a* is a curved hemispherical image (front side) taken through the lens **102***a*. Further, as illustrated in FIG. **3**B, an image captured by the imaging element **103***b* is a curved hemispherical image (back side) taken through the lens **102***b*. The image capturing device **10** combines the hemispherical image (front side) and the hemispherical image (back side), which are reversed by 180 degrees from each other, to generate the equirectangular projection image EC as illustrated in FIG. **3**C.

(51) The image capturing device **10** uses Open Graphics Library for Embedded Systems (OpenGL ES) to map the equirectangular projection image EC so as to cover the sphere surface as illustrated in FIG. **4**A, to generate the spherical image CE as illustrated in FIG. **4**B. That is, the spherical image CE is represented as the equirectangular projection image EC, which corresponds to a surface facing a center of the sphere CS. It should be noted that OpenGL ES is a graphic library used for visualizing two-dimensional (2D) and three-dimensional (3D) data. The spherical image CE is either a still image or a moving image.

(52) Since the spherical image CE is an image attached to the sphere surface to cover the sphere surface, as illustrated in FIG. **4**B, a part of the image may look distorted when viewed from the user, providing a feeling of strangeness. To resolve this strange feeling, the image capturing device **10** displays an image of a predetermined area T, which is a part of the spherical image CE, as a flat image having fewer curves. The predetermined area is, for example, a part of the spherical image CE that is viewable by the user. In this disclosure, the image of the predetermined area, which is viewable, may be referred to as a "predetermined-area image" or "viewable-area image" Q. That is, the term "predetermined-area image" and "viewable-area image" may be used interchangeably. Hereinafter, a description is given of displaying the predetermined-area image Q with reference to FIGS. **5** to **8**.

(53) FIG. **5** is a view illustrating positions of a virtual camera IC and a predetermined area T in a case in which the spherical image is represented as a three-dimensional solid sphere. The virtual camera IC corresponds to a position of a point of view (viewpoint) of a user who is viewing the spherical image CE represented as a surface area of the three-dimensional solid sphere CS. FIG. **6**A is a perspective view of the spherical image CE illustrated in FIG. **5**. FIG. **6**B is a view illustrating the predetermined-area image Q when displayed on a display. In FIG. **6**A, the spherical image CE illustrated in FIG. **5** is represented as a surface area of the three-dimensional (3D) solid sphere CS. Assuming that the spherical image CE having been generated is a surface area of the solid sphere CS, the virtual camera IC is inside the spherical image CE as illustrated in FIG. **5**. 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. In addition, zooming in or out the predetermined area T is also determined by bringing the virtual camera IC closer to or away from the spherical image CE. The predetermined-area image Q is an image of the predetermined area T, in the spherical image CE. The predetermined area T is defined by the angle of view α and a distance f from the virtual camera IC to the spherical image CE (see FIG. **7**).

(54) The predetermined-area image Q, which is an image of the predetermined area T illustrated in FIG. **6**A, is displayed on a display as an image of an imaging area of the virtual camera IC, as illustrated in FIG. **6**B. FIG. **6**B illustrates the predetermined-area image Q represented by the predetermined-area information that is set by default. The following explains the position of the virtual camera IC, using an imaging direction (ea, aa) and an angle of view a of the virtual camera IC. In another example, the predetermined area T is identified by an imaging area (X, Y, Z) of the virtual camera IC, i.e., the predetermined area T, rather than the angle of view α and the distance f.

(55) Referring to FIG. **7**, a relation between the predetermined-area information and the image of the predetermined area T is described according to the embodiments. FIG. **7** is a view illustrating a relation between the predetermined-area information and the image of the predetermined area T. As illustrated in FIG. **7**, "ea" denotes an elevation angle, "aa" denotes an azimuth angle, and "α" denotes an angle of view, respectively, 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 as the imaging area of the virtual camera IC. As illustrated in FIG. **7**, when it is assumed that a diagonal angle of the predetermined area T specified by the angle of view α of the virtual camera IC is α, the center point CP (x, y) provides the parameters (x, y) of the predetermined-area information. The predetermined-area image Q is an image of the predetermined area T in the spherical image CE. The distance from the virtual camera IC to the center point CP (x, y) of the predetermined area T is denoted by "f". "L" is a distance between the center point CP (x, y) and a given vertex of the predetermined area T (2L is a diagonal line). In FIG. **7**, a trigonometric function equation generally expressed by the following equation (1) is satisfied.

$$L/f=\tan(\alpha/2) \qquad (1)$$

(56) The image capturing device **10** described above is an example of an image capturing device capable of acquiring a wide-angle view image. In this disclosure, the spherical image is an example of a wide-angle view image. Here, the wide-angle view image is generally an image taken with a wide-angle lens, such as a lens capable of taking a range wider than a range that the human eye can perceive. Further, the wide-angle view image is generally an image taken with a lens having a focal length of 35 mm or less in terms of 35 mm film.

(57) FIG. **8** is a view illustrating points in a three-dimensional Euclidean space defined in spherical coordinates, according to the embodiments. Positional coordinates (r, θ, φ) are given when the center point CP is represented by a spherical polar coordinate system. The positional coordinates (r, θ, φ) represent a radius vector, a polar angle, and an azimuth angle. The radius vector r is a distance from the origin of the three-dimensional virtual space including the spherical image to the center point CP. Accordingly, the radius vector r is equal to "f". FIG. **8** illustrates the relation between these items. In the following description of the embodiments, the positional coordinates (r, θ, φ) of the virtual camera IC are used.

(58) Overview of Image Communication System

(59) A description is now given of an overview of a configuration of an image communication system according to an embodiment of the present disclosure, with reference to FIG. **9**. FIG. **9** is a diagram illustrating an example general arrangement of an image communication system **1** according to the embodiment. The image communication system **1** illustrated in FIG. **9** is a system for transmitting and receiving captured images such as video images bidirectionally among a

plurality of sites. In the image communication system **1**, a captured image such as a video image distributed from a certain site is displayed at another site, and a wide-range image (e.g., a spherical image) in which the other site appears is viewable. In the image communication system **1**, for example, a captured image of an office floor or the like, which is a predetermined site, is viewable at a remote site. The site where an image is captured is not limited to the office floor and may be any space that a user (or viewer) at a viewing site desires to remotely grasp, and examples of such a site include a school, a factory, a warehouse, a construction site, a server room, and a store.

(60) As illustrated in FIG. **9**, the image communication system **1** includes image capturing devices **10** (image capturing devices **10**A and **10**B) located at a plurality of sites (sites A and B), a communication management system **50**, and communication terminals **30** (communication terminals **30**A, **30**C, and **30**D) located at a plurality of sites (sites A, C, and D). The image capturing devices **10**A and **10**B are hereinafter referred to collectively as "image capturing devices **10**" or individually as an "image capturing device **10**" unless distinguished. The communication terminals **30**A, **30**C, and **30**D are hereinafter referred to collectively as "communication terminals **30**" or individually as a "communication terminal **30**" unless distinguished.

(61) The communication terminal **30** and the communication management system **50** of the image communication system **1** are capable of communicating with each other via a communication network **100**. The communication network **100** includes the Internet, a mobile communication network, and a local area network (LAN), for example. The communication network **100** includes a network by not only wired communications but also a network by wireless communications such as 3rd generation (3G), 4th generation (4G), 5th generation (5G), Wireless Fidelity (Wi-Fi) (registered trademark), Worldwide Interoperability for Microwave Access (WiMAX), or Long Term Evolution (LTE).

(62) The image capturing device **10** is a special digital camera, which captures an image of an object or surroundings such as scenery to obtain two hemispherical images, from which the spherical image is generated, as described above. The captured image obtained by the image capturing device **10** may be a video image or a still image, or may include both of a moving image and a still image. Further, the captured image may be managed together with audio. The captured image and the audio are provided in form of a video image. The communication terminal **30** distributes an image acquired from the image capturing device **10** via a wired cable such as a universal serial bus (USB) cable to another communication terminal **30** at a different site via the communication management system **50**. In one example, the image capturing device **10**A and the communication terminal **30**A are located at the site A where users A**1** and A**2** are located. The image capturing device **10**B is located at the site B where a user B**1** is located, and is capable of directly communicating with the communication management system **50** via the communication network **100**. The number of sites where the image capturing devices **10** are installed is not limited to two, and one site or three or more sites may be used. The connection between the image capturing device **10** and the communication terminal **30** may be a wireless connection using short-range wireless communication, for example, instead of a wired connection using a wired cable.

(63) The communication terminal **30** is a computer such as a personal computer (PC) operated by a user at each site. The communication terminal **30** displays an image (a still image and/or a moving image) distributed from another site. For example, the communication terminal **30** acquires a spherical image, which is an image captured by the image capturing device **10**, via the communication network **100**. The communication terminal **30** is installed with OpenGL ES, which enables the communication terminal **30** to generate predetermined-area information indicating an area that is a part of the spherical image, or to generate a predetermined-area image from a spherical image that is transmitted from another communication terminal **30**. That is, the communication terminal **30** is capable of displaying a predetermined area, which is a portion of an object appearing in the spherical image that is the captured image.

(64) In one example, the communication terminal **30**A is placed at the site A where the user A**1** and

the user A**2** are located, and the communication terminal **30**C is placed at the site C where a user C**1** is located. The communication terminal **30**D is placed at the site D where a user D**1**, a user D**2**, and a user D**3** are located. The communication terminals **30**C and **30**D, which are placed at the sites C and D where no image capturing device **10** is located, respectively, distribute captured images of the sites C and D, which are obtained by cameras or the like of the communication terminals **30**C and **30**D, to other sites, respectively. At the site A where both the image capturing device **10**A and the communication terminal **30**A are located, the communication terminal **30**A may distribute, to other sites, an image (spherical image) captured by the image capturing device **10**A and an image captured by a camera or the like of the communication terminal **30**A.

(65) The arrangement of the terminals and devices (i.e., the communication terminals **30** and the image capturing devices **10**) and the users illustrated in FIG. **9** is an example, and another example may be used. Examples of the communication terminal **30** are not limited to a PC, but include a tablet terminal, a mobile phone such as a smartphone, a wearable terminal, a projector, a video conference (teleconference) terminal, an interactive white board (IWB), and a telepresence robot. The IWB is an electronic whiteboard with mutual communication capability. When the image capturing device **10** includes a display, the image capturing device **10** may be configured to display an image distributed from another site.

(66) The communication management system **50** manages and controls communication among the communication terminals **30** at the respective sites and manages types of image data (e.g., general image and special image) to be transmitted and received. In this embodiment, a special image is a spherical image, and a general image is a planar image. The communication management system **50** is provided, for example, at a service provider that provides video communication service.

(67) The communication management system **50** may be configured by a single computer or a plurality of computers to which divided portions (functions) are arbitrarily allocated. All or a part of the functions of the communication management system **50** may be implemented by a server computer residing on a cloud network or a server computer residing on an on-premise network. The communication management system **50** thus may be referred to as a communication management server.

(68) An existing system for distributing video data including a spherical image allows a viewer to change a display direction for the video data as desired. Such an existing system allows a viewer at each site to view an image corresponding to a different display direction, regardless of whether the video data is distributed live in real time or is recorded and distributed. In such a system for distributing a spherical image, a distributor may desire viewers to view an image corresponding to a synchronized display direction in a time period during which an object that the distributor desires the viewers to view appears on the image or in a time period during which an object that the distributor does not desire the viewers to view appears on the image. In the existing method, however, in the distribution of a spherical image, it is difficult to display an appropriate predetermined area on a communication terminal according to the demand of the distributor or a viewer such that the viewer is allowed to operate a display direction of an image to be displayed on the communication terminal as desired in a certain time period, whereas an image corresponding to a synchronized display direction is displayed on the communication terminal in some other time period.

(69) To address such difficulty, in the image communication system **1**, the communication management system **50** stores predetermined-area information corresponding to a reproduction time of video data including a spherical image transmitted from the communication terminal **30**, and transmits, to the communication terminal **30**, the video data and the predetermined-area information corresponding to the reproduction time when recording and distributing the video data. The communication terminal **30** reproduces the received video data such that a synchronized display direction is provided for the video data when the predetermined-area information corresponding to the reproduction time is present, whereas the user is allowed to operate a display

direction for the video data as desired when the predetermined-area information corresponding to the reproduction time is not present. Accordingly, in the distribution of recorded video data including a spherical image, the image communication system **1** reflects a synchronized display direction for the recorded video data such that a viewer is allowed to operate a display direction for the video data as desired in a certain time period, whereas an image corresponding to the synchronized display direction is viewed in some other time period.

(70) Hardware Configurations

(71) Next, referring to FIGS. **10** and **11**, hardware configurations of each apparatus, device, and terminal of the image communication system are described according to the embodiment. In the hardware configurations illustrated in FIGS. **10** and **11**, components or elements may be added or deleted as needed.

(72) Hardware Configuration of Image Capturing Device

(73) First, referring to FIG. **10**, a hardware configuration of the image capturing device **10** is described, according to the present embodiment. FIG. **10** is a diagram illustrating an example hardware configuration of the image capturing device **10**. The following describes a case in which the image capturing device **10** is a spherical (omnidirectional) image capturing device having two imaging elements. However, the image capturing device **10** may include any suitable number of imaging elements, provided that it includes at least two imaging elements. In addition, the image capturing device **10** is not necessarily an image capturing device dedicated to omnidirectional image capturing. Alternatively, an external omnidirectional image capturing unit may be attached to a general-purpose digital camera or a smartphone to implement an image capturing device having substantially the same function as that of the image capturing device **10**.

(74) As illustrated in FIG. **10**, the image capturing device **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**, the 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**.

(75) 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 they need to be distinguished from each other), 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 the two imaging elements **103***a* and **103***b* corresponding to the lenses **102***a* and **102***b* respectively. The imaging elements **103***a* and **103***b* each include an imaging 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 imaging sensor converts an optical image formed by the lenses **102***a* and **102***b* into electric signals to output image data. The timing generation circuit generates horizontal or vertical synchronization signals, pixel clocks and the like for the imaging sensor. Various commands, parameters, and the like for operations of the imaging elements **103***a* and **103***b* are set in the group of registers.

(76) 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. In addition, 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**. Furthermore, 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**.

(77) The image processor **104** acquires image data from each of the imaging elements **103***a* and **103***b* via the parallel I/F bus and performs predetermined processing on each image data.

Thereafter, the image processor **104** combines these image data to generate data of the equirectangular projection image as illustrated in FIG. **3**C.

(78) The imaging controller **105** usually functions as a master device while the imaging elements **103***a* and **103***b* each usually function 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 serial I/F bus such as the I2C bus. The imaging controller **105** receives various commands from the CPU **111**. Further, the imaging controller **105** acquires status data and the like of the group of registers of each of the imaging elements **103***a* and **103***b* via the serial I/F bus such as the I2C bus. The imaging controller **105** sends the acquired status data and the like to the CPU **111**.

(79) The imaging controller **105** instructs the imaging elements **103***a* and **103***b* to output the image data at a time when a shutter button of the operation unit **115** is pressed. In some cases, the image capturing device **10** displays a preview image on a display (e.g., a display of an external terminal such as a smartphone that performs short-range communication with the image capturing device **10** through the short-range communication circuit **117**) or displays a moving image (movie). In case of displaying movie, the image data are continuously output from the imaging elements **103***a* and **103***b* at a predetermined frame rate (frames per minute).

(80) Furthermore, 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. It should be noted that, although the image capturing device **10** does not include a display in this embodiment, the image capturing device **10** may include the display. The microphone **108** converts sounds 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.

(81) The CPU **111** controls entire operation of the image capturing device **10**, for example, by performing predetermined processing. The ROM **112** stores various programs for execution by the CPU **111**. The SRAM **113** and the DRAM **114** each operate as a work memory to store programs loaded from the ROM **112** for execution by the CPU **111** or data in current processing. More specifically, in one example, the DRAM **114** stores image data currently processed by the image processor **104** and data of the equirectangular projection image on which processing has been performed.

(82) The operation unit **115** collectively refers to various operation keys, a power switch, the shutter button, and a touch panel having functions of both displaying information and receiving input from a user, which can be used in combination. The user operates the operation unit **115** to input various image capturing (photographing) modes or image capturing (photographing) conditions.

(83) The input/output I/F **116** collectively refers to an interface circuit such as a USB I/F that allows the image capturing device **10** to communicate data with an external medium such as a secure digital (SD) card or an external personal computer. The input/output I/F **116** supports at least one of wired and wireless communications. 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 needed.

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

(85) The electronic compass **118** calculates an orientation of the image capturing device **10** from the Earth's magnetism to output orientation information. This orientation information is an example of related information, which is metadata described in compliance with Exif. This information is used for image processing such as image correction of captured images. The related information

also includes a date and time when the image is captured by the image capturing device **10**, and a data size of the image data. The gyro sensor **119** detects the change in angle of the image capturing device **10** (roll, pitch, yaw) with movement of the image capturing device **10**. The change in angle is one example of related information (metadata) described in compliance with Exif. This information is used for image processing such as image correction of captured images. The acceleration sensor **120** detects acceleration in three axial directions. The image capturing device **10** calculates position (an angle with respect to the direction of gravity) of the image capturing device **10**, based on the acceleration detected by the acceleration sensor **120**. With the gyro sensor **119** and the acceleration sensor **120**, the image capturing device **10** is able to correct tilt of images with high accuracy. The network I/F **121** is an interface for performing data communication, via a router or the like, using the communication network **100** such as the Internet.

(86) Hardware Configuration of Communication Terminal

(87) FIG. **11** is a diagram illustrating an example hardware configuration of the communication terminal **30**. 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. **11**, the communication terminal **30** includes a CPU **301**, a ROM **302**, a RAM **303**, a hard disk (HD) **304**, a hard disk drive (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 medium 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**.

(88) The CPU **301** controls entire operation of the communication terminal **30**. The ROM **302** stores a control program for driving the CPU **301** such as an initial program loader (IPL). The RAM **303** is used as a work area for the CPU **301**. The HD **304** stores various data such as a control program. The HDD controller **305** controls reading or writing of various data to or from the HD **304** under control of the CPU **301**. The display **306** displays various information such as a cursor, a menu, a window, characters, or an image. The display **306** is an example of a display (display device). In one example, the display **306** is a touch panel display provided with an input device (input means). The external device connection I/F **308** is an interface for connecting to various external devices. Examples of the external devices include, but are not limited to, a USB memory and a printer. The network I/F **309** is an interface that controls communication of data through the communication network **100**. The bus line **310** is an address bus or a data bus, which electrically connects the elements in FIG. **11** such as the CPU **301**.

(89) The keyboard **311** is an example of an input device 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 device that allows a user to select or execute a specific instruction, select a target for processing, or move a cursor being displayed. The input device is 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** reads and writes various data from and to a DVD-RW **313**, which is an example of a removable recording medium. In alternative to the DVD-RW, any recording medium may be used such as a digital versatile disc recordable (DVD-R) or Blu-ray Disc (registered trademark). The medium I/F **316** controls reading or writing (storing) of data with respect to a recording medium **315** such as a flash memory. The microphone **318** is an example of an audio collecting device, which is of a built-in type, capable of inputting audio under control of the CPU **301**. The audio input/output I/F **317** is a circuit for inputting or outputting an audio signal to the microphone **318** or from the speaker **319** under control of the CPU **301**. The short-range communication circuit **320** communicates data with the external terminal (apparatus) by short-range wireless communication such as NFC, Bluetooth, or Wi-Fi. The camera **321** is an example of a built-in imaging device capable of capturing a target to obtain captured image data. Note that the microphone **318**, the speaker **319**, or the camera **321** may be an external device in alternative to the

built-in device of the communication terminal **30**.

(90) Hardware Configuration of Communication Management System

(91) FIG. **11** is a diagram illustrating an example hardware configuration of the communication management system **50**. Each hardware element of the communication management system **50** is denoted by a reference numeral in **500** series. The communication management system **50** is implemented by one or more computers and has substantially the same configuration as that of the communication terminal **30** as illustrated in FIG. **11**, and thus the description of the hardware configuration is omitted.

(92) Further, any one of the above-described control programs may be recorded in a file in a format installable or executable on a computer-readable recording medium for distribution. Examples of the recording medium include a compact disc recordable (CD-R), a digital versatile disc (DVD), Blu-ray Disc, an SD card, and a USB memory. In addition, such recording media may be provided in the domestic markets or foreign markets as program products. For example, the communication terminal **30** executes the control program to implement an image display method according to an embodiment of the present disclosure.

(93) Functional Configuration

(94) Referring to FIGS. **12** to **20**, a functional configuration of the image communication system **1** is described according to the embodiment. FIGS. **12** and **13** are diagrams illustrating an example functional configuration of the image communication system **1** according to the embodiment. FIGS. **12** and **13** illustrate some of the devices and terminals illustrated in FIG. **9**, which are related to processing or operation to be described below.

(95) Functional Configuration of Image Capturing Device

(96) Referring to FIG. **12**, a functional configuration of the image capturing device **10** is described according to the embodiment. The image capturing device **10** includes a communication unit **11**, an acceptance unit **12**, an imaging unit **13**, a sound collection unit **14**, and a storing and reading unit **19**. These units are functions that are implemented by or caused to function by operating any of the hardware elements illustrated in FIG. **10** in cooperation with the instructions of the CPU **111** according to the control program for the image capturing device expanded from the SRAM **113** to the DRAM **114**. The image capturing device **10** further includes a storage unit **1000**, which is implemented by the ROM **112**, the SRAM **113**, and the DRAM **114** illustrated in FIG. **10**. The storage unit **1000** stores a Globally Unique Identifier (GUID) identifying the own device (i.e., the image capturing device **10**).

(97) The communication unit **11** is implemented by instructions of the CPU **111**, and transmits or receives various data or information to or from any other device or terminal. The communication unit **11** communicates data with any other device or terminal using, for example, the short-range communication circuit **117**, based on short-range wireless communication technology. For example, the communication unit **11** communicates data with any other device or terminal via any desired cable through the input/output I/F **116**. Furthermore, the communication unit **11** communicates data with any other device or terminal via the communication network **100** through the network I/F **121**.

(98) The acceptance unit **12** is implemented by the operation unit **115**, which operates according to instructions of the CPU **111**, and receives various selections or inputs from the user. The imaging unit **13** is implemented by the imaging unit **101**, the image processor **104**, and the imaging controller **105**, each operating according to instructions of the CPU **111**. The imaging unit **13** captures an image of an object or surroundings (for example, scenery) to obtain captured image data. The sound collection unit **14** is implemented by the microphone **108** and the audio processor **109**, each operating according to instructions of the CPU **111**. The sound collection unit **14** collects sounds around the image capturing device **10**.

(99) The storing and reading unit **19** is implemented by instructions of the CPU **111**, and stores various data or information in the storage unit **1000** or reads out various data or information from

the storage unit **1000**.

(100) Functional Configuration of Communication Terminal

(101) Next, a functional configuration of the communication terminal **30** is described with reference to FIG. **12**. The communication terminal **30** includes a transmitting/receiving unit **31**, an acceptance unit **32**, an image and audio processing unit **33**, a display control unit **34**, a determination unit **35**, a creation unit **36**, a generation unit **37**, a communication unit **38**, an imaging unit **41**, a sound collection unit **42**, and a storing and reading unit **39**. These units are functions that are implemented by or caused to function by operating any of the hardware elements illustrated in FIG. **11** in cooperation with the instructions of the CPU **301** according to the control program for the communication terminal expanded from the HD **304** to the RAM **303**. The communication terminal **30** further includes a storage unit **3000**, which is implemented by the ROM **302**, the RAM **303**, and the HD **304** illustrated in FIG. **11**.

(102) The transmitting/receiving unit **31** (example of receiving means) is implemented by the network I/F **309**, which operates according to instructions of the CPU **301**, and transmits or receives various data or information to or from any other device or terminal through the communication network **100**.

(103) The acceptance unit **32** is implemented by the keyboard **311** or the pointing device **312**, which operates according to instructions of the CPU **301**, and receives various selections or inputs from the user.

(104) The image and audio processing unit **33** is implemented by instructions of the CPU **301**, and performs image processing on captured image data acquired by the image capturing device **10** or acquired by the camera **321** capturing an object. The image and audio processing unit **33** further processes audio data, based on audio signals, which are converted from voice of the user by the microphone **318**. For example, the image and audio processing unit **33** performs image processing on captured image data received from the image capturing device **10** or obtained by the camera **321**, based on image type information such as the source name so that the display control unit **34** causes the display **306** to display an image. Specifically, when the image type information indicates the special image, the image and audio processing unit **33** converts the captured image data (e.g., data of hemispherical images as illustrated in FIGS. **3**A and **3**B) into data of a spherical image as illustrated in FIG. **4**B to create spherical image data.

(105) Further, the image and audio processing unit **33** performs image processing on captured image data distributed from another communication terminal **30**. Further, the image and audio processing unit **33** outputs a voice signal of audio data distributed from another communication terminal **30** via the communication management system **50** to the speaker **319** and outputs a voice from the speaker **319**.

(106) The display control unit **34** is implemented by instructions of the CPU **301**, and controls the display **306** to display various screens including various images or texts. The determination unit **35** is implemented by instructions of the CPU **301**, and performs various determinations. For example, the determination unit **35** determines the image type of the captured image data received from the image capturing device **10** or obtained by the camera **321**.

(107) The creation unit **36** is implemented by instructions of the CPU **301**. The creation unit **36** generates a source name, which is one example of the image type information, according to a naming rule, based on a determination result generated by the determination unit **35** and indicating a general image or a special image (that is, a spherical image in this disclosure). For example, when the determination unit **35** determines that the image type corresponding to the received captured image data is a general image, the creation unit **36** generates the source name "Video" that indicates a general image type. By contrast, when the determination unit **35** determines that the image type corresponding to the received captured image data is a special image, the creation unit **36** generates the source name "Video_Theta" that indicates a special image type.

(108) The generation unit **37** is implemented by instructions of the CPU **301**, and generates a

predetermined-area image to be displayed on the display **306**. For example, to display on the display **306** an image of a predetermined area corresponding to predetermined-area information indicating a predetermined area in an image captured by the image capturing device **10** or predetermined-area information received by the transmitting/receiving unit **31**, the generation unit **37** applies perspective projection conversion to the captured image (spherical image) using the predetermined-area information to generate a predetermined-area image corresponding to the predetermined-area information.

(109) The communication unit **38** is implemented by the short-range communication circuit **320** that operates according to instructions of the CPU **301**, and communicates with the communication unit **11** of the image capturing device **10** using short-range wireless communication technology such as NFC, Bluetooth, or WiFi. In the above description, the communication unit **38** and the transmitting/receiving unit **31** are independent from each other; however, the communication unit **38** and the transmitting/receiving unit **31** may be configured as a single unit.

(110) The imaging unit **41** is implemented by the camera **321** that operates according to instructions of the CPU **301**, and captures an object such as scenery to acquire captured image data. The sound collection unit **42** is implemented by the microphone **318** and the audio input/output I/F **317**, which operate according to instructions of the CPU **301**, and collects sounds around the communication terminal **30**.

(111) The storing and reading unit **39** is implemented by instructions of the CPU **301**, and stores various data or information in the storage unit **3000** or reads out various data or information from the storage unit **3000**.

(112) Image Type Management Table

(113) FIG. **14** is a conceptual view illustrating an example of an image type management table. The storage unit **3000** includes an image type management DB **3002**. The image type management DB **3002** is made up of the image type management table illustrated in FIG. **14**. In the image type management table, an image data ID, an Internet Protocol (IP) address, which is an example of an address, of a transmission source terminal, and a source name are managed in association with each other. The image data ID is one example of image data identification information identifying image data to be distributed. The same identical image data ID is assigned to image data transmitted from the same transmission source terminal. By the image data ID, a transmission destination terminal (namely, a communication terminal that receives the image data) identifies the transmission source terminal of the received image data. The IP address of the transmission source terminal is the IP address of the image capturing device **10** or the communication terminal **30** that transmits image data identified by the corresponding image data ID, which is associated with the IP address. The source name, which is associated with the corresponding image data ID, is a name for identifying the image capturing device **10** or the camera **321** that outputs image data identified by the corresponding image data ID, which is associated with the source name. The source name is one example of image type information. The source name is a name generated by the communication terminal **30** according to a predetermined naming rule.

(114) For example, five transmission source terminals having the IP addresses "1.2.1.3", "1.2.2.3", "1.3.1.3", "1.3.2.3", and "1.2.2.5" have transmitted image data indicated by image data IDs "RS001", "RS002", "RS003", "RS004", and "RS005", respectively. It is also indicated that the image types indicated by the source names of the five transmission source terminals are "Video_Theta", "Video_Theta", "Video", "Video", and "Video_Theta", which indicate the image types "special image", "special image", "general image", "general image", and "special image", respectively. In this embodiment, a special image is a spherical image, and a general image is a planar image. The IP address is an example of destination information, and the destination information may be a media access control (MAC) address, a terminal identification (ID), or the like. Although the IP address is represented by simplifying the IPv4 address, the IP address may be IPv6. In addition, data other than the image data may be stored in the image type management table

in association with the image data ID. Examples of the data other than the image data include audio data and presentation material data to be shared on a screen.

(115) Image Capturing Device Management Table

(116) FIG. **15** is a conceptual view illustrating an example of an image capturing device management table. The storage unit **3000** includes an image capturing device management DB **3001**. The image capturing device management DB **3001** is made up of the image capturing device management table illustrated in FIG. **15**. The image capturing device management table stores a vendor ID and a product ID, obtainable from the GUID of the image capturing device **10** that is configured to obtain two hemispherical images, from which a spherical image is generated. As the GUID, a combination of a vendor ID (VID) and a product ID (PID) used in a USB device is used, for example. The vendor ID and the product ID may be stored in the communication terminal **30** before shipment or after shipment.

(117) Predetermined-Area Management Table

(118) FIG. **16** is a conceptual view illustrating an example of a predetermined-area management table. The storage unit **3000** includes a predetermined-area management DB **3003**. The predetermined-area management DB **3003** is made up of the predetermined-area management table illustrated in FIG. **16**. In the predetermined-area management table, a time stamp indicating the reproduction time of video data, which is captured image data, and predetermined-area information indicating a predetermined-area image to be displayed on the communication terminal **30** are managed in association with each other. The predetermined-area information is a conversion parameter used to convert a captured image to an image (predetermined-area image) of a predetermined area T of the captured image, as illustrated in FIG. **6**A, FIG. **6**B, and FIG. **7**.

(119) For example, the predetermined-area management table illustrated in FIG. **16** manages, in the first row, information indicating that video data having the reproduction time corresponding to the time stamp "10001" is to be displayed in a predetermined area (r=10, θ=20, ϕ=30). The predetermined-area management table illustrated in FIG. **16** manages, in the second row, information indicating that video data having the reproduction time corresponding to the time stamp "10002" is to be displayed in a predetermined area (r=20, θ=30, ϕ=40). The predetermined-area management table illustrated in FIG. **16** manages, in the fourth row, information indicating that video data having the reproduction time corresponding to the time stamp "10004" is to be displayed in a predetermined area (r=20, θ=20, ϕ=30). By contrast, the predetermined-area management table illustrated in FIG. **16** stores no predetermined-area information in the third row, and manages information indicating that a synchronized display direction of the predetermined-area image is not provided for the video data having the reproduction time corresponding to the time stamp "10003". When the transmitting/receiving unit **31** receives new predetermined-area information corresponding to a time stamp of video data that has already been managed, the storing and reading unit **39** rewrites the managed predetermined-area information to the received new predetermined-area information.

(120) Functional Configuration of Communication Management System

(121) Next, referring to FIG. **13**, a description is given of the functional configuration of the communication management system **50** according to the embodiment. The communication management system **50** includes a transmitting/receiving unit **51**, a determination unit **52**, a video recording processing unit **53**, a generation unit **54**, a distribution condition setting unit **55**, and a storing and reading unit **59**. These units are functions that are implemented by or caused to function by operating any of the hardware elements illustrated in FIG. **11** in cooperation with the instructions of the CPU **501** according to the control program for the communication management system expanded from the HD **504** to the RAM **503**. The communication management system **50** further includes a storage unit **5000**, which is implemented by the ROM **502**, the RAM **503**, and the HD **504** illustrated in FIG. **11**.

(122) The transmitting/receiving unit **51** is implemented by the network I/F **509**, which operates

according to instructions of the CPU **501**, and transmits or receives various data or information to or from any other device or terminal through the communication network **100**.

(123) The determination unit **52** is implemented by instructions of the CPU **501**, and performs various determinations. The video recording processing unit **53** is implemented by instructions of the CPU **501**, and records video data transmitted from the communication terminals **30**. The video data includes captured image data and audio data. For example, when the data transmitted from each of the communication terminals **30** is video data, the video recording processing unit **53** individually stores the received video data as a recording file, and stores metadata (bibliographic information) in a video data management DB **5003**.

(124) The generation unit **54** is implemented by instructions of the CPU **501**, and generates an image data ID and predetermined-area information. The generation unit **54** generates, for example, predetermined-area information. The predetermined-area information indicates a predetermined area (e.g., the predetermined area T illustrated in FIG. **5** and the like) in an image captured by the image capturing device **10**. An image in which the entire captured image is displayed (e.g., the spherical image CE illustrated in FIG. **5** and the like) is also referred to as an "entire image".

(125) The distribution condition setting unit **55** is implemented by instructions of the CPU **501**, and sets distribution conditions for distributing the video data recorded by the video recording processing unit **53** to the communication terminals **30** at the respective sites. For example, the distribution condition setting unit **55** sets, in association with a time stamp indicating a reproduction time of the recorded video data, predetermined-area information corresponding to the reproduction time.

(126) The storing and reading unit **59** is implemented by instructions of the CPU **501**, and stores various data or information in the storage unit **5000** or reads out various data or information from the storage unit **5000**.

(127) Session Management Table

(128) FIG. **17** is a conceptual view illustrating an example of a session management table. The storage unit **5000** includes a session management DB **5001**. The session management DB **5001** is made up of the session management table illustrated in FIG. **17**. In the session management table, a session ID and an IP address of a participant communication terminal are managed in association with each other. The session ID is an example of session identification information identifying a communication session for implementing image communication. The session ID is generated for each virtual room. The session ID is also managed by each communication terminal, and is used when each communication terminal selects a communication session. The IP address of the participant communication terminal indicates the IP address of the communication terminal **30** participating in a virtual room indicated by the session ID, which is associated with the IP address.

(129) Image Type Management Table

(130) FIG. **18** is a conceptual view illustrating an example of an image type management table. The storage unit **5000** includes an image type management DB **5002**. The image type management DB **5002** is made up of the image type management table illustrated in FIG. **18**. In the image type management table, the information managed by the image type management table illustrated in FIG. **14** and the same session ID as the session ID managed in the session management table illustrated in FIG. **17** are managed in association with each other. The communication management system **50** manages an image data ID, an IP address of a transmission source terminal, and image type information, which are the same as those managed in the communication terminal **30**, because, for example, when a new communication terminal **30** enters a virtual room, the communication management system **50** transmits information including the image type information to a communication terminal **30** that has already been in video communication and the new communication terminal **30**, which has just participated in the video communication. As a result, the communication terminal **30** that has already been in the video communication and the communication terminal **30** that has just participated in the video communication do not have to

transmit and receive such information including the image type information.

(131) Video Data Management Table

(132) FIG. **19** is a conceptual view illustrating an example of a video data management table. The storage unit **5000** includes the video data management DB **5003**. The video data management DB **5003** is made up of the video data management table illustrated in FIG. **19**. In the video data management table, an IP address of the communication terminal **30** or the image capturing device **10** from which captured image data is transmitted, and a recorded data file of video data, which is the captured image data, are managed in association with each other.

(133) Predetermined-Area Management Table

(134) FIG. **20** is a conceptual view illustrating an example of a predetermined-area management table. The storage unit **5000** includes a predetermined-area management DB **5004**. The predetermined-area management DB **5004** is made up of the predetermined-area management table illustrated in FIG. **20**. In the predetermined-area management table, for each recorded data file of video data, an IP address of a transmission source terminal of captured image data, an IP address of the communication terminal **30** to which the captured image data is to be transmitted, a time stamp, and predetermined-area information are managed in association with each other. The time stamp indicates a reproduction time of the video data, which is the captured image data. The predetermined-area information indicates a predetermined-area image to be displayed on the communication terminal **30**. The predetermined-area information is a conversion parameter used to convert a captured image to an image (predetermined-area image) of a predetermined area T of the captured image, as illustrated in FIG. **6**A, FIG. **6**B, and FIG. **7**.

(135) For example, the predetermined-area management table illustrated in FIG. **20** manages, in the first row, information indicating that video data having the reproduction time corresponding to the time stamp "10001" is to be transmitted from the communication terminal **30** having the IP address "1.2.1.3" to the communication terminal **30** having the IP address "1.3.1.3" via the communication management system **50** and that the predetermined area (r=10, θ=20, ϕ=30) is to be displayed on the communication terminal **30** as the transmission destination. As indicated in the second and third rows of the predetermined-area management table illustrated in FIG. **20**, when the IP address of the image transmission destination is "all", the communication management system **50** transmits predetermined-area information corresponding to each of the time stamps, which are associated with the IP address "all", to all of the communication terminals **30** to which the video data is to be distributed, and causes all of the communication terminals **30** to display the same predetermined area.

(136) As indicated in the third and sixth rows of the predetermined-area management table illustrated in FIG. **20**, when no predetermined-area information is stored, the communication management system **50** does not transmit predetermined-area information corresponding to each of the respective time stamps to the communication terminal(s) **30** (or image transmission destination(s)) to which the video data is to be distributed, or does not cause the communication terminal(s) **30** to display the predetermined-area image in a synchronized display direction. As indicated in the fourth and fifth rows of the predetermined-area management table illustrated in FIG. **20**, when different image transmission destinations or different pieces of predetermined-area information are stored for the same image transmission source and time stamp, the communication management system **50** transmits pieces of predetermined-area information, each corresponding to the associated time stamp, to the communication terminals **30** serving as the corresponding image transmission destinations, and causes each of the communication terminals **30** to display a different predetermined area.

(137) When the transmitting/receiving unit **51** receives new predetermined-area information corresponding to a set of the IP address of a communication terminal from which captured image data is transmitted, the IP address of a communication terminal to which the captured image data is to be transmitted, and the time stamp of the video data, the set having already been managed, the

storing and reading unit **59** rewrites the managed predetermined-area information to the received new predetermined-area information. The time stamp is an example of time information indicating a reproduction time of the video data. The time stamp indicates a time indicating a reproduction position within the total reproduction time of the video data in the recorded data file. The time stamp may record a time at which captured image data, which is the video data, is received from the image transmission source to represent the reproduction time of the video data.

Processes or Operations According to Embodiment

(138) Session Participation Process

(139) Next, referring to FIGS. **21** to **33**, processes and operations of the image communication system **1** according to the embodiment are described. In the following description, a captured image obtained at the site A is distributed to various sites, by way of example. However, similar processing is performed for distribution of an image from another site. Referring to FIGS. **21** and **22**, operation of processing a request for participation in a communication session is described, according to the embodiment. FIG. **21** is a sequence diagram illustrating operation of processing a request for participation in a communication session, performed by the image communication system **1**, according to the embodiment. FIG. **22** is a diagram illustrating an example of a selection screen **800** for selecting a session.

(140) When a user at the site A (e.g., the user A**1**) operates the communication terminal **30**A to display a session selection screen for selecting a communication session, the acceptance unit **32** receives an instruction for displaying the session selection screen. The display control unit **34** of the communication terminal **30**A causes the display **306** to display the selection screen **800** as illustrated in FIG. **22** (S**11**). The selection screen **800** illustrated in FIG. **22** displays selection buttons **810***a*, **810***b*, and **810***c*, which correspond to rooms A**1**, B**1**, and B**2**, respectively, for selection. Each of the selection buttons **810***a*, **810***b*, and **810***c* is associated with a corresponding session ID.

(141) When the user A**1** selects a selection button (in this example, the selection button **810***a*) corresponding to a desired virtual room as the desired site, the acceptance unit **32** of the communication terminal **30**A receives selection of a corresponding communication session (S**12**). Then, the transmitting/receiving unit **31** of the communication terminal **30**A transmits to the communication management system **50** a participation request to participate in the communication session with another site (S**13**). This participation request includes a session ID identifying the communication session for which the selection is received at S**12**, and the IP address of the communication terminal **30**A, which is a request sender terminal. The communication management system **50** receives the participation request at the transmitting/receiving unit **51**.

(142) Next, the storing and reading unit **59** of the communication management system **50** performs a process for causing the communication terminal **30**A to participate in the communication session (S**14**). More specifically, the storing and reading unit **59** adds, in the session management DB **5001** (FIG. **17**), the IP address that is received at S**13** to a field of the participant terminal IP address in a record of the session ID that is the same as the session ID received at S**13**. The transmitting/receiving unit **51** transmits a response to the participation request to the communication terminal **30**A (S**15**). The response to the participation request includes the session ID received at S**13** and the result of the participation process performed at S**14**. The communication terminal **30**A receives the response to the participation request at the transmitting/receiving unit **31**. The following describes a case where the operation for causing the communication terminal **30**A to participate in the communication session, namely, the participation process, is successfully completed. Through a process similar to the process illustrated in FIG. **21**, the communication terminals **30** at the respective sites perform a process for participating in the communication session.

(143) Operation of Managing Image Type Information

(144) Next, referring to FIG. **23**, operation of managing the image type information is described,

according to the embodiment. FIG. **23** is a sequence diagram illustrating operation of managing the image type information, performed by the image communication system **1**, according to the embodiment.

(145) When a user at the site A connects the image capturing device **10**A to the communication terminal **30**A, the storing and reading unit **19** of the image capturing device **10**A reads the GUID of the own device (i.e., the image capturing device **10**A) stored in the storage unit **1000**. Then, the communication unit **11** of the image capturing device **10**A transmits the GUID of the image capturing device **10**A to the communication terminal **30**A (S**31**). Thus, the communication unit **38** of the communication terminal **30**A receives the GUID of the image capturing device **10**A.

(146) The determination unit **35** of the communication terminal **30**A determines whether a vendor ID and a product ID, which are the same as a vendor ID and a product ID of the GUID received at S**31**, are stored in the image capturing device management DB **3001** (see FIG. **15**) to determine the image type (S**32**). More specifically, the determination unit **35** of the communication terminal **30**A determines that the image capturing device **10**A is an image capturing device that captures a special image (a spherical image, in this embodiment), when the same vender ID and product ID are stored in the image capturing device management DB **3001**. By contrast, the determination unit **35** of the communication terminal **30**A determines that the image capturing device **10**A is an image capturing device that captures a general image, when the same vender ID and product ID are not stored in the image capturing device management DB **3001**.

(147) Then, the storing and reading unit **39** of the communication terminal **30**A stores, in the image type management DB **3002** (hereinafter also referred to as the "image type management DB **3002**A" when distinguished from those of the other communication terminals **30**; the same applies to the other communication terminals **30**) (see FIG. **14**), the IP address of the transmission source terminal (i.e., the communication terminal **30**A), and image type information indicating the determination result obtained at S**32** in association with each other (S**33**). In this state, any image data ID is not yet associated. Examples of the image type information include a source name, which is determined according to the naming rule, and an image type (general image or special image).

(148) Next, the transmitting/receiving unit **31** of the communication terminal **30**A transmits a request for addition of the image type information to the communication management system **50** (S**34**). The request for addition of the image type information includes the IP address of the transmission source terminal (i.e., the communication terminal **30**A) and the image type information, which are stored at S**33**. The communication management system **50** receives the request for addition of the image type information at the transmitting/receiving unit **51**.

(149) Subsequently, the storing and reading unit **59** of the communication management system **50** refers to the session management DB **5001** (see FIG. **17**) using the IP address of the transmission source terminal, which is received at S**34**, as a search key, to search for and read the session ID associated with the IP address (S**35**).

(150) Next, the generation unit **54** generates a unique image data ID (S**36**). Then, the storing and reading unit **59** adds, in the image type management DB **5002** (see FIG. **18**), a new record associating the session ID read at S**35**, the image data ID generated at S**36**, and the IP address of the transmission source terminal and the image type information, which are received at S**34**, with one another (S**37**). The transmitting/receiving unit **51** transmits the image data ID generated at S**36** to the communication terminal **30**A (S**38**). The communication terminal **30**A receives the image data ID at the transmitting/receiving unit **31**.

(151) Then, the storing and reading unit **39** of the communication terminal **30**A stores, in the image type management DB **3002**A (see FIG. **14**), the image data ID received at S**38** in association with the IP address of the transmission source terminal (i.e., the communication terminal **30**A) and the image type information, which are stored at S**33** (S**39**).

(152) Further, the transmitting/receiving unit **51** of the communication management system **50**

transmits a notification indicating the addition of the image type information to another communication terminal **30** (in the illustrated example, the communication terminal **30**D) (S**40**). The notification indicating the addition of the image type information includes the image data ID generated at S**36**, and the IP address of the transmission source terminal (i.e., the communication terminal **30**A) and the image type information, which are stored at S**37**. The communication terminal **30**A receives the notification indicating the addition of the image type information at the transmitting/receiving unit **31**. The transmitting/receiving unit **51** transmits the notification indicating the addition of the image type information to another IP address that is associated with the same session ID as that of the IP address of the communication terminal **30**A in the session management DB **5001** (see FIG. **17**). That is, the notification indicating the addition of the image type information is transmitted to another communication terminal **30** in the same virtual room as that of the communication terminal **30**A.

(153) Then, the storing and reading unit **39** of the communication terminal **30**D stores, in the image type management DB **3002**D (see FIG. **14**), a new record associating the image data ID, the IP address of the transmission source terminal (i.e., the communication terminal **30**A), and the image type information, which are received at S**40**, with one another (S**41**). The notification indicating the addition of the image type information is also transmitted to another communication terminal **30**, namely, the communication terminal **30**C, and is stored in the image type management DB **3002**C of the communication terminal **30**C. Accordingly, the communication terminals **30**A, **30**C, and **30**D can share the same information in the image type management DBs **3002**A, **3002**C, and **3002**D, respectively.

(154) Process for Communicating Captured Image Data

(155) Next, operation of transmitting captured image data and audio data that are obtained at the site A to other communication terminals (i.e., the communication terminals **30**C and **30**D) via the communication management system **50** is described with reference to FIGS. **24** and **25**. FIG. **24** is a sequence diagram illustrating operation of transmitting captured image data and audio data, performed by the image communication system **1**, according to the embodiment. FIG. **24** illustrates an example in which captured image data acquired by one image capturing device **10** is distributed to the communication terminals **30**. However, similar processing is performed when a plurality of captured image data acquired by other image capturing devices **10** installed in the same site are distributed.

(156) First, the communication unit **11** of the image capturing device **10**A transmits to the communication terminal **30**A captured image data acquired by capturing an object or surroundings such as scenery and audio data acquired by collecting sounds (S**51**). In this case, since the image capturing device **10**A is capable of obtaining two hemispherical images from which a spherical image is generated, as illustrated in FIGS. **3**A and **3**B, the captured image data includes data of two hemispherical images. The communication terminal **30**A receives the captured image data and the audio data at the communication unit **38**.

(157) Then, the transmitting/receiving unit **31** of the communication terminal **30**A transmits to the communication management system **50** the captured image data and the audio data sent from the image capturing device **10**A (S**52**). Along with the captured image data and the audio data, an image data ID identifying the captured image data, which is a transmission target, is also transmitted. The communication management system **50** receives the captured image data, the audio data, and the image data ID at the transmitting/receiving unit **51**.

(158) Then, the transmitting/receiving unit **51** of the communication management system **50** transmits the captured image data and the audio data to the communication terminals (the communication terminals **30**C and **30**D) participating in the same session as the session in which the communication terminal **30**A is participating (S**53** and S**54**). Along with the captured image data and the audio data, an image data ID identifying the captured image data, which is a transmission target, is also transmitted. The communication terminals **30**C and **30**D receive the

captured image data, the audio data, and the image data ID at the respective transmitting/receiving units **31**.

(159) Referring to FIG. **25**, an example display on the communication terminal **30** at each site is described. FIG. **25** is a view illustrating an example of a display screen displayed on the communication terminal **30**. A display screen **200** displays captured images of the respective sites, which are based on captured image data. For example, when an image captured at a predetermined site is a spherical image, the display screen **200** displays a spherical image and a predetermined-area image, which are generated from captured image data sent from the other sites.

(160) When the captured image data sent from the image capturing devices **10**A and **10**B, which are capable of capturing spherical images, is displayed as is, the images of the sites A and B are each displayed as a hemispherical image of the front side and a hemispherical image of the rear side as respectively illustrated in FIGS. **3**A and **3**B. In contrast, when the generation unit **37** generates a spherical image from the captured image data output from each of the image capturing devices **10**A and **10**B, which are capable of obtaining two hemispherical images from which a spherical image is generated, and further generates a predetermined-area image, as illustrated in FIG. **25**, a predetermined-area image that is a planar image is displayed. The images of the sites C and D are displayed as general images (in the illustrated example, planar images) because the communication terminal **30**C configured to obtain a general image captures the image of the site C and the communication terminal **30**D configured to obtain a general image captures the image of the site D.

(161) The users at the respective sites are able to change a predetermined area corresponding to a predetermined-area image in the same spherical image. For example, each user at each site operates the input device, such as the pointing device **312**, to allow the acceptance unit **32** to receive movement of the predetermined-area image and the display control unit **34** to shift or rotate the predetermined-area image or reduce or increase the size of the predetermined-area image.

(162) The image of the site A is displayed in a left display area (with the layout number "1") of the display screen **200**, and the image of the site B is displayed in an upper right display area (with the layout number "2") of the display screen **200**. The image of the site C is displayed in a middle-right display area (with the layout number "3") of the display screen **200**, and the image of the site D is displayed in a lower right display area (with the layout number "4") of the display screen **200**. The display area having the layout number "1" is a main display area, and the display areas having the layout numbers "2", "3", and "4" are sub-display areas. The image in the main display area and the images in the sub display areas can be changed in each communication terminal. In general, an image in which a main person in the video communication is included is displayed in the main display area at each site.

(163) In FIG. **25**, spherical icons **210**a and **210**b are examples of a special image identification icon for identifying a predetermined-area image representing the predetermined area T, which is a portion of the spherical image. The spherical icons **210**a and **210**b may be displayed at any position such as an upper left corner, a lower left corner, or a lower right corner, instead of the upper right corner. The type of the spherical icons **210**a and **210**b is not limited to that illustrated in FIG. **25**. Instead of the spherical icons **210**a and **210**b, characters such as "spherical image" may be used, or a combination of an icon and characters may be used.

(164) Video Data Recording Process

(165) Next, operation of recording video data transmitted from the communication terminal **30** at each site in the communication management system **50** is described with reference to FIG. **26**. FIG. **26** is a flowchart illustrating an example of a video data recording process. The video data recording process illustrated in FIG. **26** is executed when the communication management system **50** receives captured image data, as in S**52** in FIG. **24**.

(166) First, the determination unit **52** of the communication management system **50** determines whether the data transmitted from the communication terminal **30** (e.g., the communication

terminal **30**A illustrated in FIG. **24**) from which the captured image data and the like are transmitted is video data. When the determination unit **52** determines that video data is received by the transmitting/receiving unit **51** (YES at S**71**), the process proceeds to S**72**.

(167) Then, the video recording processing unit **53** stores the data file of the video data received by the transmitting/receiving unit **51** in the video data management DB **5003** (see FIG. **19**) (S**72**). In this case, the video recording processing unit **53** stores the IP address of the transmission source of the received video data and a recorded data file (e.g., a file name) of the received video data in the video data management DB **5003** in association with each other. For example, the video recording processing unit **53** combines captured image data and audio data transmitted from the communication terminal **30** at each site to obtain a single recorded data file for each site, and stores the recorded data files for the respective sites in the video data management DB **5003**.

(168) When the determination unit **52** determines that the data received by the transmitting/receiving unit **51** is not video data (NO at S**71**), the process proceeds to S**73**.

(169) Then, the determination unit **52** determines whether predetermined-area information has been received from the communication terminal **30** (e.g., the communication terminal **30**C or the communication terminal **30**D illustrated in FIG. **24**) used to view captured image data distributed from another site. In live distribution of video data, the communication terminal **30** transmits predetermined-area information to the communication management system **50** to constantly notify the communication management system **50** of which spherical image is being viewed at the site where the communication terminal **30** is installed, when the communication terminal **30** is to display a spherical image in a display direction synchronized with that of another communication terminal **30**. When the determination unit **52** determines that predetermined-area information has been received by the transmitting/receiving unit **51** from the communication terminal **30** (YES at S**73**), the process proceeds to S**74**. Then, the storing and reading unit **59** stores the predetermined-area information received by the transmitting/receiving unit **51** in the predetermined-area management DB **5004** (see FIG. **20**) (S**74**). In this case, the storing and reading unit **59** stores the received predetermined-area information in the predetermined-area management DB **5004** in association with the IP addresses of the transmission source and the transmission destination of the video data corresponding to the received predetermined-area information and a time stamp indicating the reproduction time of the video data corresponding to the received predetermined-area information.

(170) When the determination unit **52** determines at S**73** that predetermined-area information has not been received by the transmitting/receiving unit **51** (NO at S**73**), the process ends. In live distribution of video data, when the communication terminal **30** is to display a spherical image in a display direction that is not synchronized with that of another communication terminal **30**, the communication terminal **30** does not transmit predetermined-area information, or performs control not to cause the communication management system **50** to store predetermined-area information.

(171) Distribution Condition Setting Process

(172) Next, operation of setting distribution conditions of recorded video data is described with reference to FIGS. **27** and **28**. FIG. **27** is a sequence diagram illustrating an example of a distribution condition setting process. Referring to FIG. **27**, a description will be given of a case where the user A**1** at the site A uses the communication terminal **30**A to set distribution conditions of video data including a spherical image captured by the image capturing device **10**A.

(173) First, the transmitting/receiving unit **31** of the communication terminal **30**A transmits a distribution condition setting request to the communication management system **50** in response to a predetermined input operation performed by the user A**1** (S**91**). The communication management system **50** receives the distribution condition setting request transmitted from the communication terminal **30**A at the transmitting/receiving unit **51**.

(174) Then, the storing and reading unit **59** of the communication management system **50** searches the video data management DB **5003** (see FIG. **19**) using as a search key the IP address of the

communication terminal **30**A from which the distribution condition setting request received at S**91** is transmitted, to read the data file of the video data associated with the IP address of the communication terminal **30**A (S**92**). Then, the transmitting/receiving unit **51** transmits the video data read at S**92** to the communication terminal **30**A from which the distribution condition setting request is transmitted (S**93**). The communication terminal **30**A receives the video data transmitted from the communication management system **50** at the transmitting/receiving unit **31**.

(175) Then, the display control unit **34** of the communication terminal **30**A causes the display **306** to display a distribution condition setting screen **700** (S**94**). FIG. **28** is a view illustrating an example of the distribution condition setting screen **700**. The distribution condition setting screen **700** illustrated in FIG. **28** is a screen for setting a predetermined area to be displayed on the communication terminal **30** when video data is distributed to each site during reproduction of recorded video data. The distribution condition setting screen **700** includes an image display area **710**, a reproduction position display area **730**, a predetermined-area information display area **740**, a setting button **750**, and a "finish" button **755**. The image display area **710** displays an image based on video data being reproduced. The reproduction position display area **730** displays a reproduction position of the video data. The predetermined-area information display area **740** indicates a predetermined area corresponding to a display direction specified in the image display area **710**. The setting button **750** is pressed to set distribution conditions. The "finish" button **755** is pressed to finish the setting of distribution conditions.

(176) The image display area **710** includes display direction change buttons **720** (**720***a*, **720***b*, **720***c*, and **720***d*) for changing the display direction for the video data. For example, the user A**1** selects a desired one of the display direction change buttons **720** to change the display direction of the image to be displayed in the image display area **710**. The reproduction position display area **730** includes a play button **731**, a pause button **732**, and a slider **735**. The play button **731** is pressed to reproduce the video data. The pause button **732** is pressed to stop the reproduction of the video data. The slider **735** indicates a reproduction history (reproduction position) relative to the entire reproduction time. The slider **735** forms a seek bar. The seek bar is an operation area for designating a reproduction position of the video data. The seek bar displays the reproduction position of the video data. The slider **735** allows the user A**1** to visually grasp, for example, which portion of the video data is being reproduced from the beginning to the end of the video data. Further, for example, the user A**1** can move the slider **735** using the input device, such as the pointing device **312**, to reproduce the video data from a desired reproduction position.

(177) The predetermined-area information display area **740** presents predetermined-area information corresponding to the predetermined-area image displayed in the image display area **710**. In the predetermined-area information display area **740**, values of the predetermined area corresponding to the predetermined-area image being displayed are changed as appropriate by changing the display direction of the image to be displayed in the image display area **710** in response to, for example, the user A**1** selecting and moving any one of the display direction change buttons **720**. The user A**1** may manually input the values of the predetermined area to be displayed in the predetermined-area information display area **740** to change the display direction of the image to be displayed in the image display area **710**.

(178) The acceptance unit **32** of the communication terminal **30**A receives input of distribution conditions in response to the user A**1** selecting any one of the display direction change buttons **720** or inputting numerical values in the predetermined-area information display area **740** and pressing the setting button **750** (S**95**). In this case, the acceptance unit **32** receives predetermined-area information selected or input by the user A**1** as distribution conditions. Then, the transmitting/receiving unit **31** of the communication terminal **30**A transmits to the communication management system **50** the predetermined-area information input at S**95** and time information indicating the reproduction time of the video data corresponding to the input predetermined-area information (S**96**). The communication management system **50** receives the predetermined-area

information and the time information, which are transmitted from the communication terminal **30**A, at the transmitting/receiving unit **51**.

(179) Then, the distribution condition setting unit **55** of the communication management system **50** stores the time stamp corresponding to the predetermined-area information and the time information received at S**96** in the predetermined-area management DB **5004** (see FIG. **20**) in association with the IP address of the communication terminal **30**A from which the distribution condition setting request received at S**91** is transmitted (S**97**). In this case, for example, the distribution condition setting unit **55** sets the IP address of the image transmission destination, which is to be stored in association with the received predetermined-area information, to "all". When the predetermined-area information to be stored matches predetermined-area information corresponding to a set of a transmission source of the captured image data and a time stamp of the video data that has already been managed in the predetermined-area management DB **5004**, the distribution condition setting unit **55** rewrites the managed predetermined-area information to the received new predetermined-area information.

(180) When an IP address of a specific image transmission destination corresponding to predetermined-area information to be stored in the predetermined-area management DB **5004** has already existed, the distribution condition setting unit **55** may use the IP address of the specific image transmission destination that has already existed, as is, without setting the IP address of the image transmission source to "all". Alternatively, for example, the distribution condition setting unit **55** may be configured to prompt the user A**1** to input the IP address of the image transmission destination using the distribution condition setting screen **700** illustrated in FIG. **28** to store the IP address of the specific image transmission destination in association with the received predetermined-area information.

(181) Recorded Data Distribution Process

(182) Next, operation of distributing video data recorded in the communication management system **50** is described with reference to FIGS. **29** to **33**. FIG. **29** is a sequence diagram illustrating an example of a recorded video data distribution process. The example illustrated in FIG. **29** presents a description of operation of distributing video data recorded by the communication management system **50** to the communication terminal **30**C at the site C.

(183) First, the transmitting/receiving unit **31** of the communication terminal **30**C transmits a video distribution request to the communication management system **50** in response to a predetermined input operation performed by the user C**1** (S**111**). The video distribution request includes information for identifying the video data for which distribution is requested (e.g., the IP address of the transmission source of the video data or the file name of the video data). The communication management system **50** receives the video distribution request transmitted from the communication terminal **30**C at the transmitting/receiving unit **51**.

(184) Then, the storing and reading unit **59** of the communication management system **50** reads, from the predetermined-area management DB **5004** (see FIG. **20**), predetermined-area information corresponding to the video data specified by the video distribution request received at S**111** (S**112**). In this case, the storing and reading unit **59** reads the intended predetermined-area information and the time stamp associated with the predetermined-area information. Then, the transmitting/receiving unit **51** transmits, to the communication terminal **30**C from which the request is transmitted, a set of the predetermined-area information read at S**112** and time information indicating a reproduction time identified by the time stamp associated with the predetermined-area information (S**113**). The communication terminal **30**C receives the set of the predetermined-area information and the time information, which is transmitted from the communication management system **50**, at the transmitting/receiving unit **31**. The communication management system **50** may perform the processing of S**112** and S**113** at once on all of the target pieces of predetermined-area information stored in the predetermined-area management DB **5004**, or may sequentially perform the processing of S**112** and S**113** every certain period (e.g., 30

seconds) in accordance with the reproduction time of the video data.

(185) Then, the storing and reading unit **39** of the communication terminal **30**C stores the predetermined-area information received at S**113** and the time stamp corresponding to the time information received at S**113** in the predetermined-area management DB **3003** (hereinafter also referred to as the "predetermined-area management DB **3003**C" when distinguished from those of the other communication terminals **30**) (see FIG. **16**) in association with each other (S**114**).

(186) Then, the storing and reading unit **59** of the communication management system **50** reads, from the video data management DB **5003** (see FIG. **19**), the recorded data file of the video data specified by the video distribution request received at S**11** (S**115**). Then, the transmitting/receiving unit **51** sequentially transmits the captured image data and the audio data of the video data, based on the recorded data file read at S**115**, to the communication terminal **30**C from which the request is transmitted (S**116**). Along with the captured image data and the audio data, an image data ID identifying the captured image data, which is a transmission target, is also transmitted. The communication terminal **30**C receives the captured image data and the audio data transmitted from the communication management system **50** at the transmitting/receiving unit **31**.

(187) Then, the display control unit **34** of the communication terminal **30**C reproduces the video data received at S**116** to display the captured image (S**117**). When a plurality of recorded data files have been simultaneously recorded in the same session, the communication management system **50** may simultaneously distribute the recorded data files to the communication terminal **30**C, and the communication terminal **30**C may display the recorded data files in combination when viewing them. In response to the video distribution request at S**111**, the communication management system **50** may distribute data to each individual communication terminal **30** or synchronously distribute data to a plurality of communication terminals **30**.

(188) An example of the display of an image based on recorded video data on the communication terminal **30**C is described with reference to FIGS. **30** to **33**. First, referring to FIGS. **30** and **31**, reproduction of video data in a case where a synchronized display direction is provided for the video data is described. FIG. **30** is a flowchart illustrating an example process for reproducing video data on the communication terminal **30**C.

(189) First, as illustrated at S**113** in FIG. **29**, when the predetermined-area information transmitted from the communication management system **50** has been received by the communication terminal **30**C (YES at S**131**), the process proceeds to S**132**. When the predetermined-area information has not been received by the communication terminal **30**C (NO at S**131**), the process ends.

(190) Then, as illustrated at S**114** in FIG. **29**, the storing and reading unit **39** of the communication terminal **30**C stores the predetermined-area information received at S**131** in the predetermined-area management DB **3003**C in association with a time stamp indicating a reproduction time of the video data corresponding to the predetermined-area information (S**132**).

(191) The following processing is performed in reproducing video data.

(192) The determination unit **35** of the communication terminal **30**C refers to the predetermined-area management DB **3003**C in which the predetermined-area information is stored at S**132**, and determines whether the predetermined-area information corresponding to the time stamp of the video data transmitted from the communication management system **50** is stored in the predetermined-area management DB **3003**C. When the predetermined-area information corresponding to the time stamp of the video data transmitted from the communication management system **50** is present in the predetermined-area management DB **3003**C (YES at S**133**), the process proceeds to S**134**. By contrast, when the predetermined-area information corresponding to the time stamp of the video data transmitted from the communication management system **50** is not present in the predetermined-area management DB **3003**C (NO at S**133**), the process ends without providing a synchronized display direction for the video data.

(193) Then, to display an image of a predetermined area identified by the predetermined-area information stored at S**132** in a synchronized display direction for the video data, the generation

unit **37** of the communication terminal **30**C applies perspective projection conversion using the predetermined-area information received at S**131** to generate a predetermined-area image (S**134**). As a result, the communication terminal **30**C can generate the predetermined-area image corresponding to the distribution conditions set by the communication management system **50**.

(194) Then, the display control unit **34** causes the display **306** to display the predetermined-area image generated at S**134** (S**135**).

(195) FIG. **31** is a view illustrating an example of a display screen displayed on the communication terminal **30**C when a synchronized display direction is provided. The example illustrated in FIG. **31** presents a display screen **400** on which an image based on video data corresponding to a synchronized display direction is displayed in a predetermined reproduction time. The display screen **400** includes a predetermined-area image **410**, a synchronization completion icon **415**, and a reproduction position display area **430**. The predetermined-area image **410** is generated from the video data at S**134**. The synchronization completion icon **415** indicates that a synchronized display direction is provided. The reproduction position display area **430** displays a reproduction position of the video data. The reproduction position display area **430** includes a play button **431**, a pause button **432**, and a slider **435**. The play button **431** is pressed to reproduce the video data. The pause button **432** is pressed to stop the reproduction of the video data. The slider **435** indicates a reproduction history (reproduction position) relative to the entire reproduction time. The play button **431**, the pause button **432**, and the slider **435** have configurations similar to those of the play button **731**, the pause button **732**, and the slider **735** illustrated in FIG. **28**.

(196) As described above, the communication management system **50** causes the communication terminal **30**C to display a predetermined-area image corresponding to distribution conditions set by the communication management system **50**, and enables the communication terminal **30**C to display an image based on video data corresponding to a synchronized display direction. In this case, the user C**1** is not allowed to change the display direction while viewing the predetermined-area image **410** displayed on the display screen **400**. The synchronization completion icon **415** displayed on the display screen **400** allows the user C**1** to grasp that the display direction for the video data is not changeable. The predetermined-area information transmitted from the communication management system **50** to the communication terminal **30**C may be information transmitted from the communication terminal **30** for viewing at the time of live distribution of the video data and stored in the communication management system **50**, as illustrated at S**74** in FIG. **26**, or may be information stored in the communication management system **50** in accordance with the distribution condition setting process, as illustrated at S**97** in FIG. **27**.

(197) Next, referring to FIGS. **32** and **33**, reproduction of video data in a case where a synchronized display direction is not provided is described. FIG. **32** is a flowchart illustrating an example process for changing a display direction on the communication terminal **30**C.

(198) First, when a synchronized display direction is provided for the video data transmitted from the communication management system **50** (YES at S**151**), the communication terminal **30**C ends the process. In this case, as illustrated at S**134** and S**135** in FIG. **30**, the communication terminal **30**C displays the predetermined-area image corresponding to the synchronized display direction. When no synchronized display direction is provided for the video data (NO at S**151**), the communication terminal **30**C causes the process to proceed to S**152**.

(199) Then, the communication terminal **30**C determines whether a change of the display direction for the video data has been received (S**152**). FIG. **33** is a view illustrating an example of a display screen displayed on the communication terminal **30**C when no synchronized display direction is provided. The display screen **400** illustrated in FIG. **33** includes a predetermined-area image **410**, which is an image of any predetermined area of the video data received at S**116** in FIG. **29**, display direction change buttons **420** (**420**a, **420**b, **420**c, and **420**d) for changing the display direction for the video data, and a reproduction position display area **430** that displays a reproduction position of the video data. For example, the user C**1** selects a desired one of the display direction change

buttons **420** to change the display direction for the video data corresponding to the predetermined-area image **410** to be displayed. The reproduction position display area **430** has a configuration similar to that illustrated in FIG. **31**.

(200) When the acceptance unit **32** of the communication terminal **30**C receives a change of the display direction in response to the user C**1** selecting any one of the display direction change buttons **420** (YES at S**152**), the process proceeds to S**153**. When the acceptance unit **32** of the communication terminal **30**C has not received a change of the display direction (NO at S**152**), the process ends.

(201) Then, the storing and reading unit **39** of the communication terminal **30**C stores predetermined-area information indicating a predetermined area corresponding to the display direction received at S**152** in the predetermined-area management DB **3003**C in association with a time stamp indicating the reproduction time of the video data corresponding to the predetermined-area information (S**153**).

(202) Then, to display an image of a predetermined area identified by the predetermined-area information stored at S**153**, the generation unit **37** of the communication terminal **30**C applies perspective projection conversion using the predetermined-area information stored at S**153** to generate a predetermined-area image (S**154**). Then, the display control unit **34** causes the display **306** to display the predetermined-area image generated at S**154** (S**155**).

(203) As described above, when no synchronized display direction is provided for video data by the communication management system **50**, the communication terminal **30**C may display a predetermined-area image corresponding to a desired display direction in response to an input operation of the user C**1**.

(204) As described above, in the distribution of recorded video data including a spherical image, the image communication system **1** reflects a synchronized display direction for the recorded video data such that a viewer is allowed to operate a display direction for the video data as desired in a certain time period, whereas an image corresponding to the synchronized display direction is viewed in some other time period. Accordingly, the image communication system **1** can cause the communication terminal **30** to display an image corresponding to an appropriate display direction in accordance with the reproduction time of video data captured at a different site.

(205) In the image communication system **1**, furthermore, the communication management system **50** sets, for a recorded data file of video data transmitted from the image capturing device **10** or the communication terminal **30** at each site, predetermined-area information corresponding to a reproduction time of the video data for video recording and distribution to allow the communication terminal **30** to display an image based on the recorded video data in a synchronized display direction.

(206) In the above-described embodiments, 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, but the present disclosure is not limited thereto. The predetermined area T may be specified by predetermined point information indicating the center point CP or an arbitrary point of four corners of the predetermined area T having a rectangular shape in FIG. **7**. In such a case, it is assumed that an angle of view is constant. In the above-described embodiments, a captured image (whole image) is a three-dimensional spherical panoramic image, as an example of a spherical image. In another example, the captured image is a two-dimensional panoramic image, as an example of a spherical image.

(207) Each of the functions of the described embodiments may be implemented by one or more processing circuits or circuitry. Processing circuitry includes a programmed processor, such as a processor including circuitry. A processing circuit also includes devices such as an application specific integrated circuit (ASIC), a digital signal processor (DSP), a field programmable gate array (FPGA), a system on a chip (SOC), a graphics processing unit (GPU), and conventional circuit

components arranged to perform the recited functions.

(208) Each of the tables of the above-described embodiment may be generated by learning effect of machine learning. In addition, in alternative to using the tables, the data of each related item may be classified by the machine learning. In the present disclosure, the machine learning is defined as a technology that makes a computer acquire human-like learning ability. In addition, the machine learning refers to a technology in which a computer autonomously generates an algorithm required for determination such as data identification from learning data loaded in advance and applies the generated algorithm to new data to make a prediction. Any suitable learning method is applied for machine learning, for example, any one of supervised learning, unsupervised learning, semi-supervised learning, reinforcement learning, and deep learning, or a combination of two or more those learning.

(209) 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.

(210) The present invention can be implemented in any convenient form, for example using dedicated hardware, or a mixture of dedicated hardware and software. The present invention may be implemented as computer software implemented by one or more networked processing apparatuses. The processing apparatuses include any suitably programmed apparatuses such as a general purpose computer, a personal digital assistant, a Wireless Application Protocol (WAP) or third-generation (3G)-compliant mobile telephone, and so on. Since the present invention can be implemented as software, each and every aspect of the present invention thus encompasses computer software implementable on a programmable device. The computer software can be provided to the programmable device using any conventional carrier medium (carrier means). The carrier medium includes a transient carrier medium such as an electrical, optical, microwave, acoustic or radio frequency signal carrying the computer code. An example of such a transient medium is a Transmission Control Protocol/Internet Protocol (TCP/IP) signal carrying computer code over an IP network, such as the Internet. The carrier medium may also include a storage medium for storing processor readable code such as a floppy disk, a hard disk, a compact disc read-only memory (CD-ROM), a magnetic tape device, or a solid state memory device.

Claims

1. A communication terminal, comprising: circuitry configured to: receive, from another communication terminal, predetermined area information and video data including a captured image, the predetermined area information corresponding to a reproduction time of the video data and indicating a predetermined area of the captured image, the receiving being performed in response to at least one of inputting or selecting the predetermined area information by a first user, the predetermined area information having been selected at the another communication terminal; and reproduce the video data to a second user at a different location than the first user, while synchronizing a display direction of the video data based on the predetermined area information corresponding to the reproduction time, wherein a display direction of the image of the video data cannot be changed by a user while the user is viewing the predetermined area.

2. The communication terminal of claim 1, wherein: the video data is recorded image data distributed by the another communication terminal, and the circuitry is further configured to reproduce the recorded image data while synchronizing the display direction of the recorded image data, when the recorded image data is being reproduced.

3. The communication terminal of claim 1, wherein the captured image is a full-spherical image.

4. An image communication system comprising: a first communication terminal; and a second communication terminal, the first communication terminal including first circuitry configured to transmit, to the second communication terminal, predetermined area information and video data including a captured image, the predetermined area information corresponding to a reproduction

time of the video data and indicating a predetermined area of the captured image, the transmitting being performed in response to at least one of inputting or selecting the predetermined area information by a first user, the predetermined area information having been selected at the first communication terminal, the second communication terminal including second circuitry configured to reproduce the video data to a second user at a different location than the first user, while synchronizing a display direction of the video data based on the predetermined area information corresponding to the reproduction time that is received from the first communication terminal, wherein a display direction of the image of the video data cannot be changed by a user while the user is viewing the predetermined area.

5. A method, comprising: receiving, from another communication terminal, predetermined area information and video data including a captured image, the predetermined area information corresponding to a reproduction time of the video data and indicating a predetermined area of the captured image, the receiving being performed in response to at least one of inputting or selecting the predetermined area information by a first user, the predetermined area information having been selected at the another communication terminal; and reproducing the video data to a second user at a different location than the first user, while synchronizing a display direction of the video data based on the predetermined area information corresponding to the reproduction time, wherein a display direction of the image of the video data cannot be changed by a user while the user is viewing the predetermined area.

6. The method of claim 5, wherein: the video data is recorded image data distributed by the another communication terminal, and the method further comprises reproducing the recorded image data while synchronizing the display direction of the recorded image data, when the recorded image data is being reproduced.

7. The method of claim 5, wherein the captured image is a full-spherical image.

8. A non-transitory computer readable medium storing computer instructions which when executed by one or more processors cause the following method to be performed: receiving, from another communication terminal, predetermined area information and video data including a captured image, the predetermined area information corresponding to a reproduction time of the video data and indicating a predetermined area of the captured image, the receiving being performed in response to at least one of inputting or selecting the predetermined area information by a first user, the predetermined area information having been selected at the another communication terminal; and reproducing the video data to a second user at a different location than the first user, while synchronizing a display direction of the video data based on the predetermined area information corresponding to the reproduction time, wherein a display direction of the image of the video data cannot be changed by a user while the user is viewing the predetermined area.

9. The non-transitory computer readable medium of claim 8, wherein: the video data is recorded image data distributed by the another communication terminal, and the method further comprises reproducing the recorded image data while synchronizing the display direction of the recorded image data, when the recorded image data is being reproduced.

10. The non-transitory computer readable medium of claim 8, wherein the captured image is a full-spherical image.

11. A method, comprising: providing a communication terminal with a function to receive, from another communication terminal, predetermined-area information and video data including a captured image, the predetermined-area information corresponding to a reproduction time of the video data and indicating a predetermined area of the captured image the receiving being performed in response to at least one of inputting or selecting the predetermined-area information by a first user, the predetermined-area information having been selected at the another communication terminal; and providing the communication terminal with a function of reproducing the video data to a second user at a different location than the first user, while synchronizing a display direction of the video data based on the predetermined-area information corresponding to

the reproduction time, wherein a display direction of the image of the video data cannot be changed by a user while the user is viewing the predetermined area.

12. The communication terminal according to claim 1, further comprising: a plurality of communication terminals including the communication terminal, wherein there is set a predetermined area that is different for each of the plurality of communication terminals, and transmits the predetermined-area that are different and the video data to the plurality of communication terminals.

13. The image communication system according to claim 4, further comprising: a plurality of communication terminals including the second communication terminal, wherein there is set a predetermined area that is different for each of the plurality of communication terminals, and transmits the predetermined-area that are different and the video data to the plurality of communication terminals.

14. The method according to claim 5, wherein: a plurality of communication terminals include the communication terminal, and there is set a predetermined area that is different for each of the plurality of communication terminals, and there is transmitted the predetermined-area that is different and the video data to the plurality of communication terminals.

15. The non-transitory computer readable medium according to claim 8, wherein: a plurality of communication terminals include the communication terminal, and there is set a predetermined area that is different for each of the plurality of communication terminals, and there is transmitted the predetermined-area that is different and the video data to the plurality of communication terminals.