the like, and are communicably connected with one another.

[0013] Each of the terminal devices 10 is an information processing device that acquires video and audio of the base being installed, and transmits the video and audio to the terminal devices 10 in the other bases. The terminal device 10 also receives video and audio from the terminal devices 10 installed in the other bases, and outputs the video and audio. The relay device 30 is an information processing device that is interposed between the terminal devices 10, and that relays content data. The transmission management device 50 is an information processing device that executes processes (such as login authentication of the terminal device and monitoring communication state of the communication network) required for operating the system and that centrally manages various types of management information.

[0014] FIG. 2 is a diagram conceptually illustrating an aspect of data transmission in the teleconference system 1 of the present embodiment. In the present embodiment, a specific session S_i for management information is established between each of the terminal devices 10 and the transmission management device 50, to transmit and receive various types of management information. The terminal devices 10 and the transmission management device 50 transmit and receive various types of management information using the session S_i. In the present embodiment, a session S_d for data is established between each of the terminal devices 10 and the relay device 30, to transmit and receive content data. The terminal devices 10 and the ~~transmission management device 50~~ relay device 30 transmit and receive content data using the session S_d.

[0015] Each of the terminal devices 10 can transmit a plurality of pieces of content data at the same time. The

terminal device 10 also transmits data using the specific session S_d being established separately. For example, the content data may be image data (moving image and still image) and audio data. The content data may also include text data.

[0016] The system configuration of the teleconference system 1 of the present embodiment has been briefly described above. Next, the devices that configure the teleconference system 1 will be described.

[0017] First, the configuration of the terminal device 10 of the present embodiment will be described. FIG. 3 is an external view of the terminal device 10 of the present embodiment. It is to be noted that the external view illustrated in FIG. ~~2~~ 3 is merely an example. As illustrated in FIG. 3, the terminal device 10 includes a casing 1100, an arm 1200, and a camera housing 1300. An air intake surface (not illustrated) formed of a plurality of air intake holes is provided on a front side wall surface 1110 of the casing 1100. An air discharge surface 1121 formed of a plurality of air discharge holes is provided on a rear side wall surface 1120 of the casing 1100. Thus, the outside air is taken in from the ~~rear~~front of the terminal device 10 through the air intake surface (not illustrated), and is discharged to the rear of the terminal device 10 through the air discharge surface 1121, by driving a cooling fan built in the casing 1100. A sound collecting hole 1131 for collecting sound is formed on a right side wall surface 1130 of the casing 1100, and the sound of a conference is collected by a built-in microphone (will be described below), through the sound collecting hole 1131.

[0018] An operation panel 1150 is formed at the side of the right side wall surface 1130 of the casing 1100. The operation panel 1150 includes a plurality of operation

buttons (108a to 108e), which will be described below, a power source switch 109, which will be described below, and an alarm lamp ~~119~~1190. The operation panel 1150 also includes a sound output surface 1151 formed of a plurality of sound output holes, through which the output sound from a built-in speaker 115, which will be described below, is passed. An accommodating unit 1160 in a concave shape to accommodate the arm 1200 and the camera housing 1300 is formed at the side of a left side wall surface 1140 of the casing 1100. A plurality of connection ports (1132a to 1132c) each used to electrically connect a cable with an external device connection interface (I/F) 119, which will be described below, are provided on the right side wall surface 1130 of the casing 1100. A connection port (not illustrated) used to connect a cable 120c for a display 120 with the external device connection I/F 119, which will be described below, is provided on the left side wall surface 1140 of the casing 1100.

[0019] The arm 1200 is mounted on the casing 1100 via a torque hinge 1210, and the arm 1200 is rotatable in the vertical direction relative to the casing 1100, within a range of a tilt angle θ1 of 135 degrees. FIG. 3 illustrates the state when the tilt angle θ1 is 90 degrees.

[0020] A built-in camera (will be described below) is installed in the camera housing 1300, and the built-in camera captures images of the conference. The camera housing 1300 is mounted on the arm 1200 via a torque hinge 1310, and the camera housing 1300 is rotatable in the vertical and horizontal directions relative to the arm 1200, within a range of a pan angle θ2 of ± 180 degrees as well as within a range of a tilt angle θ3 of ±45 degrees, when the state illustrated in FIG. 3 is 0 degree.

[0021] The external view of the terminal device 10 of

source creates and displays the destination list that has reflected the state of the terminal device 10 as the destination candidate, based on the destination list information and the operation state information of the terminal, stored in the management information storage unit (step 14). FIG. 11 exemplarily illustrates the destination list displayed on the display 120 connected to the terminal device 10.

[0047] The process executed when the terminal device 10 logs into the teleconference system 1 has been described above. In the present embodiment, in response to the user selecting a desired terminal device 10 from the destination list (see FIG. 11) that is displayed, the transmission and reception of content data between the selected terminal device 10 and the terminal device 10 of the user will be in a standby mode. When the terminal device 10 selected by the user has already been in conference with the other terminal device 10, the transmission and reception of content data between (the terminal device 10 of) the user and all the terminal devices 10 that are participating in the conference will be in a standby mode.

[0048] The process executed when the terminal device 10 logs into the teleconference system 1 and participates in the conference has been described above. Next, functional blocks of the terminal device 10 and the relay device 30 of the present embodiment will be described.

[0049] FIG. 12 illustrates functional blocks of the terminal device 10 and the relay device 30 of the present embodiment. As illustrated in FIG. 12, the terminal device 10 of the present embodiment includes a code amount change requesting unit 12, a code amount changing unit 13, a last output time updating unit 14, and a transmission and reception unit 15.

[0055] The user participates in a conference by selecting a desired destination from the destination list (see FIG. 11) displayed on the display 120 of the terminal device 10a. At this time, a user interface (UI) control unit (not illustrated) of the terminal device 10a displays an input screen for receiving the registration and cancellation of the content data the user wishes to transmit on the display 120.

[0056] When the user selects the content data the user wishes to transmit via the input screen, the UI control unit (not illustrated) transmits a registration request of the selected content data to the relay device 30 (~~S1~~step S21).

[0057] Consequently, the relay device 30 assigns a data ID that is unique in the conference in which the terminal device 10 is currently participating, to each content data the registration of which is requested by the terminal device 10a. The relay device 30 also generates content data registration information that is a list of data names and data IDs of the content data registered by all the terminal devices 10 (including the terminal device 10a) that are participating in the conference (~~S2~~step S22). The relay device 30 then transmits the content data registration information to the terminal device 10a (~~S3~~step S23).

[0058] At the same time, the relay device 30 generates a reduction request history management table 600 (updates the content if the reduction request history management table 600 has already been generated) illustrated in (a) of FIG. 14 (~~S4~~step S24). As illustrated in (a) of FIG. 14, the reduction request history management table 600 includes a field 602 for storing a session ID, a field 604 for storing a data ID, and a field 606 for storing the terminal ID of the terminal device 10 having been the transmission source of the code amount reduction request corresponding to the content data,

relative to the content data relayed by the relay device 30. The reduction request history management table 600 manages the values of the fields in an associated manner.

[0059] The code amount change requesting unit 12 of the terminal device 10a generates an output state management table 700 illustrated in (a) of FIG. 15, in response to the UI control unit (not illustrated) receiving the content data registration information from the relay device 30 (~~S5~~step S25). As illustrated in (a) of FIG. 15, the output state management table 700 includes a field 702 for storing a data ID, a field 704 for storing the last output time, and a field 706 for storing the state corresponding to the code amount reduction request, relative to the content data received from the other terminal devices 10 (10b, 10c, 10d…).

[0060] Subsequently, the UI control unit (not illustrated) of the terminal device 10a generates a selection screen including a list of content data to be received by the terminal device 10a in the conference, based on the content data registration information received from the relay device 30. The UI control unit then displays the selection screen on the display 120 (~~S6~~-step S26). The user then selects at least one of the content data the user wishes to output without delay, via the input screen. More specifically, the user who regards the comments of the participants in the conference most important may select the audio data of each base, from a plurality of pieces of content data to be received.

[0061] In response to receiving an input selected by the user via the UI control unit (not illustrated), the code amount change requesting unit 12 sets the data ID of the selected content data, in the field 702 of the output state management table 700 (~~S7~~step S27). (b) of FIG. 15 illustrates the

the latest last output time is set in the field 704 corresponding to the data ID of each data.

[0068] The description will continue by returning to FIG. 13. The code amount change requesting unit 12 continues to monitor the field 704 in the output state management table 700 that is updated by the last output time updating unit 14. As a result, the code amount change requesting unit 12 generates a code amount reduction request of the selected content data, in response to detecting the output delay of the content data, using the following procedure.

[0069] First, upon detecting the output delay of the selected content data, the code amount change requesting unit 12 determines whether the network communication speed measured by a communication speed measurement unit 17 exceeds a predetermined threshold. If the measured value is below the predetermined threshold, the code amount change requesting unit 12 estimates that the cause of the output delay is the "transmission delay". In addition, the code amount change requesting unit 12 determines whether the CPU usage rate measured by a CPU usage rate measurement unit 18 exceeds a predetermined threshold. If the measured value exceeds the predetermined threshold, the code amount change requesting unit 12 estimates that the cause of the output delay is the "internal processing delay". The code amount change requesting unit 12 then generates a code amount reduction request including the data ID of the content data the output delay of which is detected, the terminal ID of the terminal device 10a, and the estimated cause (at least one of the "transmission delay" and the "internal processing delay").

[0070] Then, the code amount change requesting unit 12 transmits the generated code amount reduction request to the relay device 30 (~~S8~~step S28) while designating the other

terminal device 10, which is the transmission source of the content data, as the destination. Consequently, the output state management table 700 is updated (~~S9~~step S29). The reduction request history management unit 34 of the relay device 30 then updates the reduction request history management table 600, when the relay control unit 32 has received the code amount reduction request from the terminal device 10a (~~S10~~step S30).

[0071] In this example, it is assumed that the code amount change requesting unit 12 of the terminal device 10a transmits a code amount reduction request including a data ID "XOS0021A", a terminal ID "XTK0001" of the terminal device 10a, and the estimated cause ("Network" indicating the transmission delay) to the relay device 30. In this case, in the output state management table 700, as illustrated in (d) of FIG. 15, the field 706 corresponding to the data ID "XOS0021A" is updated to "in request". In the reduction request history management table 600, as illustrated in (b) of FIG. 14, the terminal ID "XTK0001" of the terminal device 10a serving as the transmission source of the code amount reduction request, and the estimated cause ("Network" indicating the transmission delay) are stored in the field 606 corresponding to the data ID "XOS0021A" included in the code amount reduction request. In other words, in the present embodiment, the request history (which terminal device 10 has transmitted the code amount reduction request of each content data based on what cause) of each content data is held in the field 606 of the reduction request history management table 600.

[0072] After the reduction request history management unit 34 of the relay device 30 has updated the reduction request history management table 600, the relay control unit 32 transfers the code amount reduction request received from the terminal device 10a to the other terminal

device 10 serving as the transmission source of the content data corresponding to the data ID "XOS0021A" (~~S11~~step S31).

[0073] The code amount changing unit 13 of the other terminal device 10 that has received the code amount reduction request from the relay control unit 32 of the relay device 30 retrieves the data ID and the estimated cause from the code amount reduction request, and executes a process of reducing the code amount of the content data corresponding to the data ID according to the estimated cause (~~S12~~step S32).

[0074] More specifically, if the estimated cause is the "transmission delay", the code amount changing unit 13 executes a process of increasing the compression rate of the target content data (in other words, a process of reducing the bit rate). If the estimated cause is the "internal processing delay", the code amount changing unit 13 executes a process of reducing the sampling rate for the audio data, and a process of reducing the resolution for the image data. If the estimated cause includes both the "transmission delay" and the "internal processing delay", the code amount changing unit 13 executes a process of increasing the compression rate as well as reducing the sampling rate for the audio data, and executes a process of increasing the compression rate as well as reducing the resolution for the image data. If the reduction request history management table 600 is updated as illustrated in (b) of FIG. 14, the code amount changing unit 13 of the other terminal device 10 serving as the transmission source of the content data corresponding to the data ID "XOS0021A", retrieves the data ID "XOS0021A" and the estimated cause "Network" from the received code amount reduction request, and executes a process of increasing the compression rate (process of reducing the bit rate) for the audio data

corresponding to the data ID "XOS0021A".

[0075] As a result of executing the series of processes (~~S8 to S12~~step S28 to S32) described above, the terminal device 10a can reliably receive the audio data (data ID "XOS0021A") of the other terminal device 10 without being intermitted.

[0076] Then, the code amount change requesting unit 12 of the terminal device 10a continues to monitor the field 704 of the output state management table 700. As a result, in response to sufficiently solving the output delay of the content data the code amount of which is being requested to be reduced, the code amount change requesting unit 12 generates a notification to withdraw the code amount reduction request corresponding to the content data (hereinafter, referred to as a code amount reduction request withdrawal notification) using the following procedure.

[0077] First, upon detecting that the output delay of the content data the code amount of which is being requested to be reduced has been sufficiently solved, the code amount change requesting unit 12 generates a code amount reduction request withdrawal notification including the data ID of the content data and the terminal ID of the terminal device 10a.

[0078] The code amount change requesting unit 12 then transmits the generated code amount reduction request withdrawal notification to the relay device 30 while designating the transmission source of the content data as the destination (~~S13~~step S33). Consequently, the output state management table 700 is updated (~~S14~~step S34). Meanwhile, the reduction request history management unit 34 of the relay device 30 updates the reduction request history management table 600, when the relay control unit 32 has received the code amount reduction request withdrawal notification from

the terminal device 10a (~~S15~~step S25).

[0079] In this example, it is assumed that the code amount change requesting unit 12 of the terminal device 10a transmits the code amount reduction request withdrawal notification including the data ID "XOS0021A" and the terminal ID "XTK0001" of the terminal device 10a, to the relay device 30. In this case, in the output state management table 700, as illustrated in (a) of FIG. 16, "in request" stored in the field 706 corresponding to the data ID "XOS0021A" is deleted. Meanwhile, in the reduction request history management table 600, as illustrated in (b) of FIG. 16, the request history "XTK0001(Network)" is deleted from the field 606 corresponding to the data ID "XOS0021A" included in the code amount reduction request.

[0080] In this example, after deleting the request history "XTK0001(Network)" from the field 606 corresponding to the data ID "XOS0021A" included in the code amount reduction request, the reduction request history management unit 34 of the relay device 30 determines whether all the request history corresponding to the data ID "XOS0021A" have been deleted. As a result, if all the request history corresponding to the data ID "XOS0021A" have been deleted, the reduction request history management unit 34 transfers the code amount reduction request withdrawal notification with respect to the data ID "XOS0021A" received from the terminal device 10a, to the other terminal device 10 having been designated as the destination (~~S16~~step S36).

[0081] Meanwhile, as illustrated in (b) of FIG. 16, for one piece of content data (data ID "YOS0031A"), if there is request history transmitted from two or more terminal devices 10 (terminal IDs = "XOS0002" and "XTK0003") and a part of the request history is deleted, the code amount reduction request withdrawal notification with respect to

the content data will not be transferred to the other terminal device 10 that is the transmission source of the content data as long as all the request history are not deleted (in other words, as long as all the code amount reduction requests with respect to the content data are not withdrawn).

[0082] The code amount changing unit 13 of the other terminal device 10 that has received the code amount reduction request withdrawal notification from the relay device 30, retrieves the data ID from the code amount reduction request withdrawal notification, and performs a process of recovering the code amount of the content data corresponding to the data ID, to the standard state before the code amount has been reduced (~~S17~~step S37). More specifically, the code amount changing unit 13 recovers the parameter that has been changed to reduce the code amount to the original value, among the compression rate, the sampling rate (audio data), and the resolution (image data) of the target content data.

[0083] As a result of executing the series of processes (~~S13 to S17~~step S33 to S37) described above, the terminal device 10a can receive the audio data (data ID "XOS0021A") of the other terminal device 10 in original standard quality, as soon as the cause of the output delay has been solved.

[0084] The contents of the processes cooperatively executed by the functional units illustrated in FIG. 12 have been described above based on the sequence diagram illustrated in FIG. 13. Next, the transmission processes of the code amount reduction request and the code amount reduction request withdrawal notification executed by the code amount change requesting unit 12 will be described in detail based on the flowchart illustrated in FIG. 17.

[0085] As illustrated in FIG. 17, a routine executed by

the code amount change requesting unit 12 includes a first loop process (step S100) and a subsequent second loop process (step S200). The code amount change requesting unit 12 repeatedly executes the routine including the two loop processes at a predetermined timing.

[0086] In the first loop process (step S100), the following steps S101 to S103 are executed on n pieces (n = integer equal to or more than one) of selected data that is content data the user wishes to output without delay. At step S101, it is determined whether the elapsed time period from the last output time of the selected data has exceeded a first threshold T1.

[0087] As a result, if the elapsed time period from the last output time has not exceeded the threshold T1 (No at step S101), the process returns to step 101, and it is determined whether the elapsed time period from the last output time of the next selected data has exceeded the first threshold T1.

[0088] At step S101, if it is determined that the elapsed time period from the last output time has exceeded the threshold T1 (Yes at step S101), a recovery counter for the selected data corresponding to the determination is cleared to zero (step S102). Then, a code amount reduction request of the selected data is transmitted to the relay device 30 (step S103).

[0089] Herein, the threshold T1 described above is defined as the upper limit value of the output time interval of the output signal corresponding to the allowable output delay. If the output time interval exceeds the threshold T1, the user senses a delay in image and audio. The threshold T1 may be a common value for both the audio data and image data, or a specific value may be defined for each type of data.

[0090] When the first loop process (step S100) is finished for n-pieces of selected data, the process proceeds to the subsequent second loop process (step S200). In the second loop process (step S200), the following steps S201 to S207 are executed on one or more pieces of content data (hereinafter, referred to as data the reduction of which is being requested) that has been the target of the code amount reduction request in the first loop process (step S100).

[0091] At step S201, a threshold T2 is set according to the value of a recovery completion counter (a setting method of the threshold T2 will be described below).

[0092] At subsequent step S202, the output state management table 700 is referred to calculate the elapsed time period from the difference between the last output time when a value is last stored in the field 704 corresponding to the data the reduction of which is being requested, and the current time. Then, it is determined whether the elapsed time period is less than the threshold T2.

[0093] As a result of the determination at step S202, if it is determined that the elapsed time period is not less than the threshold T2 (No at step S202), the process proceeds to step S207, and the recovery counter for the data the reduction of which is being requested, is cleared to zero.

[0094] Meanwhile, if it is determined that the elapsed time period is less than the threshold T2 (Yes at step S202), the process proceeds to step S203, and the recovery counter for the data the reduction of which is being requested is incremented by one. Then, at subsequent step S204, it is determined whether the value of the recovery counter has reached a threshold N.

[0095] As a result of the determination at step S204, if it is determined that the value of the recovery counter has not reached the threshold N, the process returns to step S201 again, and sets the second threshold T2 for the next selected data.

[0096] If it is determined that the value of the recovery counter has reached the threshold N (Yes at step S204), the code amount reduction request withdrawal notification of the selected data corresponding to the recovery counter is transmitted to the relay device 30 (step S205). Then, the recovery completion counter is incremented by one (step S206).

[0097] Upon executing the above second loop process (step S200) on all the data the reduction of which is being requested, the first loop process (step S100) will be started again at the next appropriate timing, and the procedure described above will be repeated thereafter.

[0098] The threshold T2 set at the previous step S201 will now be described. As is obvious from the above description, in the present embodiment, the recovery completion counter for the selected data is incremented, every time the code amount reduction request withdrawal notification is transmitted to the relay device 30 for certain selected data. In the preferred embodiment, a suitable threshold function is defined so that a smaller value is output as the value of the recovery completion counter becomes greater. This is to prevent unstable control that is caused by transmitting the code amount reduction request and the code amount reduction request withdrawal notification repeatedly and alternately. Then at step S201, the threshold T2 is dynamically set by using the defined threshold function. In the present embodiment, for example, the threshold function indicated by the

following formula (1) may be employed.

[0099]

$$T2 = T2_{init} - [(T2_{init} - T2_{\min})/N] \times \text{Recovery completion counter value} \quad (1)$$

[0100] In the above formula (1), $T2_{int}$ indicates the initial value, $T2_{min}$ indicates the time interval during which data corresponding to the output signal is transmitted from the transmission source, and N indicates the limit value of the recovery completion times. In this example, $T2_{int}$ needs to be a value sufficiently smaller than the threshold T1, as well as the value larger than $T2_{min}$. The value $T2_{int}$ may be a common value for both the audio data and image data, or a specific value may be defined for each type of data (audio or image).

[0101] As is obvious from the above description, in the present embodiment, the code amount change requesting unit 12 transmits a code amount reduction request of the selected data to the relay device, immediately after detecting a sign of output delay (S101, S102, and S103). On the other hand, in view of the stable operation, the withdrawal of the code amount reduction request is carried out after the stable output of the selected data has continued for a predetermined time or more (in other words, the code amount reduction request will not be withdrawn until step S203 in the second loop process has been repeated for N times). Thus, it is preferable to define a suitable value according to the object of the stable operation, for the threshold N that is referred to determine at step S204. Also, in the preceding explanation, the threshold T2 has been suitably optimized. However, the threshold T2 may also be a fixed value, and in this case, a suitable value (a value sufficiently smaller than the threshold T1 as well as larger than $T2_{min}$) according to the object of the stable operation may be obtained experimentally.

data with another terminal device via a communication network, the terminal device comprising:

a code amount change requesting unit that, based on an output time interval of an output signal corresponding to predetermined content data, transmits a code amount reduction request to request reduction of a code amount of the predetermined content data while designating a transmission source of the predetermined content data as a destination, and

a code amount changing unit that, in response to a code amount reduction request transmitted from the other terminal device, reduces a code amount of corresponding content data.

~~10. A program executable by a computer for controlling a terminal device that transmits or receives content data with another terminal device via a communication network, the computer program causing the computer to execute:~~

~~a code amount change requesting step of, based on an output time interval of an output signal corresponding to predetermined content data, transmitting a code amount reduction request to request reduction of a code amount of the predetermined content data while designating a transmission source of the predetermined content data as a destination, and~~

~~a code amount changing step of, in response to a code amount reduction request transmitted from another terminal device, reducing a code amount of corresponding content data.~~

~~11~~10. A method of transmitting or receiving content data between a first terminal device and a second terminal device via a communication network, the method comprising:

a first process of transmitting, by the first terminal device, based on an output time interval of an output signal corresponding to predetermined content data, a code amount reduction request to request reduction of a code amount of the predetermined content data to the second terminal device that is a transmission source of the predetermined content data, and

a second process of reducing, by the second terminal device, the code amount of corresponding content data in response to the code amount reduction request.

~~12~~11. The method according to claim ~~11~~10, wherein the first process includes a process of transmitting the code amount reduction request with respect to the predetermined content data, when the output time interval of the output signal corresponding to the predetermined content data exceeds a first threshold.

~~13~~12. The method according to claim ~~12~~11, further comprising

a process of transmitting, by the first terminal device, a code amount reduction request withdrawal notification to withdraw the code amount reduction request with respect to the predetermined content data to the second terminal device, when the output time interval of the content data is less than a second threshold that is smaller than the first threshold after the first process, and

a process of recovering, by the second terminal device, the code amount of the corresponding content data to a state before being reduced, in response to the code amount reduction request withdrawal notification.