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(54) CLIENT/SERVER MULTIMEDIA PRESENTATION SYSTEM

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Publication Classification

(51) **Int. Cl.**[7] **H04N 7/173**

(52) **U.S. Cl.** **725/88**; 725/105

(57) **ABSTRACT**

A method of presenting, at a client terminal, a video program stored in a server linked with the client terminal via transmission path of a limited transmission band width. Each frame of the video program comprises a basic data portion and at least one level of quality supplement data portions. In the method, in response to one of play control commands from a user, the client terminal determines a start position in the video program according to the issued play control command. The play control commands includes a play, a stop, a head search, a jump forward and a jump backward command. In response to the issued play command, the terminal obtains and uses the basic data portions for playing the video program. In response to the stop command, the terminal obtains the quality supplement data portions for the last displayed frame and uses them for displaying a quality-enhanced version of the last displayed frame.

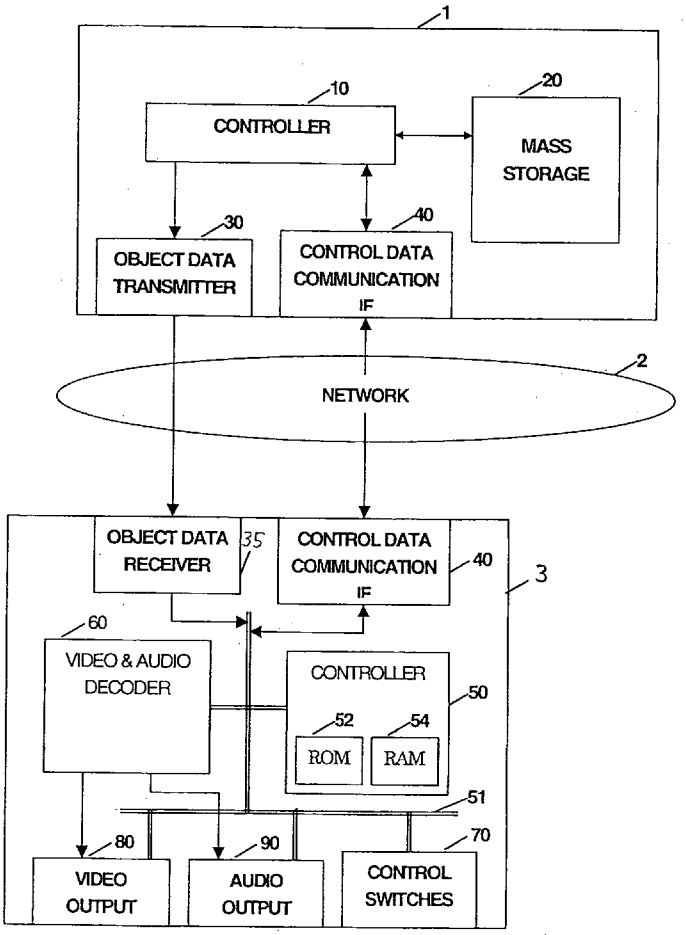

FIG. 1

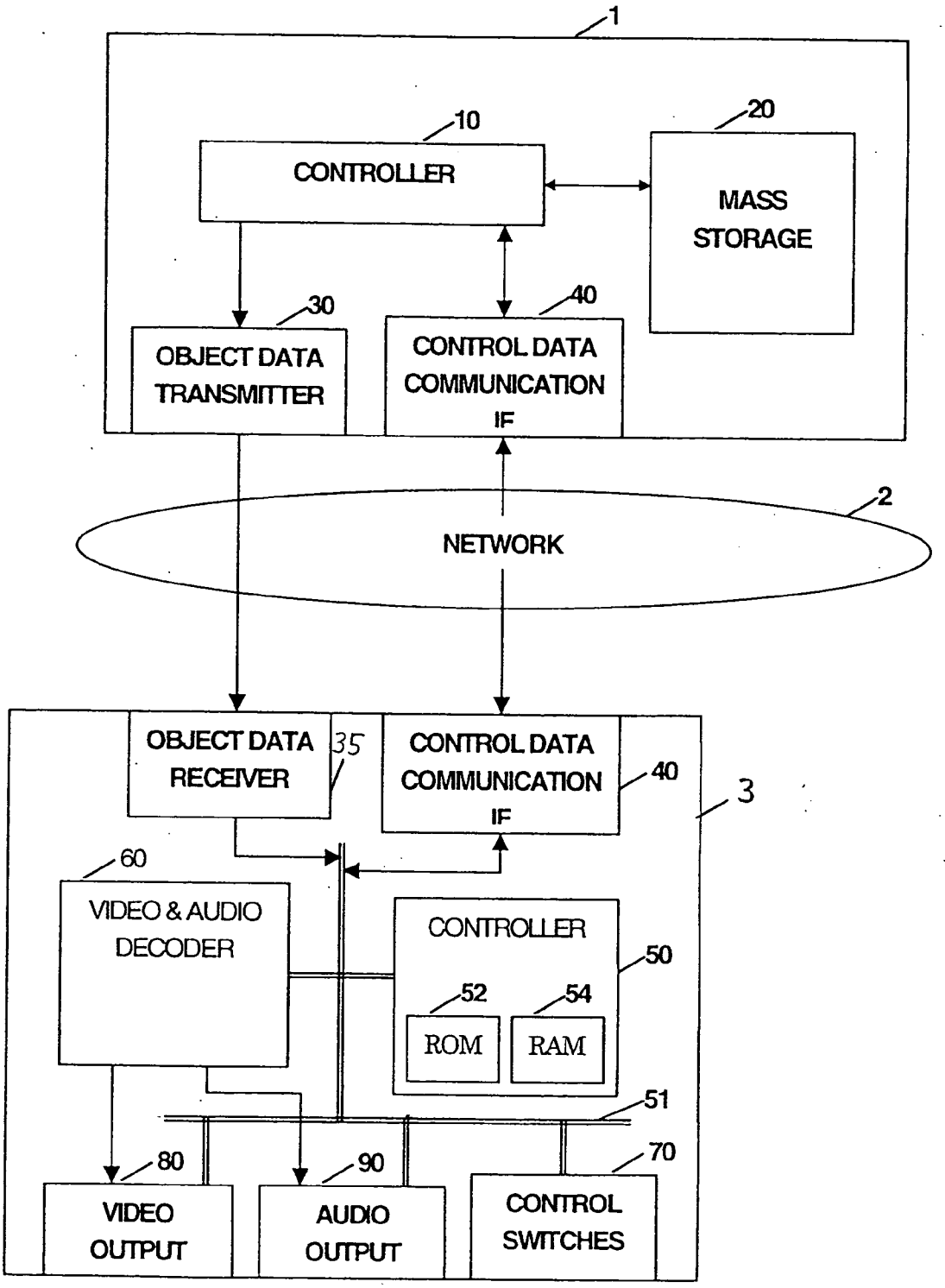
1
10
CONTROLLER
20
MASS STORAGE
30
OBJECT DATA TRANSMITTER
40
CONTROL DATA COMMUNICATION IF
2
NETWORK
OBJECT DATA RECEIVER
35
CONTROL DATA COMMUNICATION IF
40
3
60
VIDEO & AUDIO DECODER
CONTROLLER
50
52
54
ROM
RAM
51
80
90
70
VIDEO OUTPUT
AUDIO OUTPUT
CONTROL SWITCHES

FIG. 2

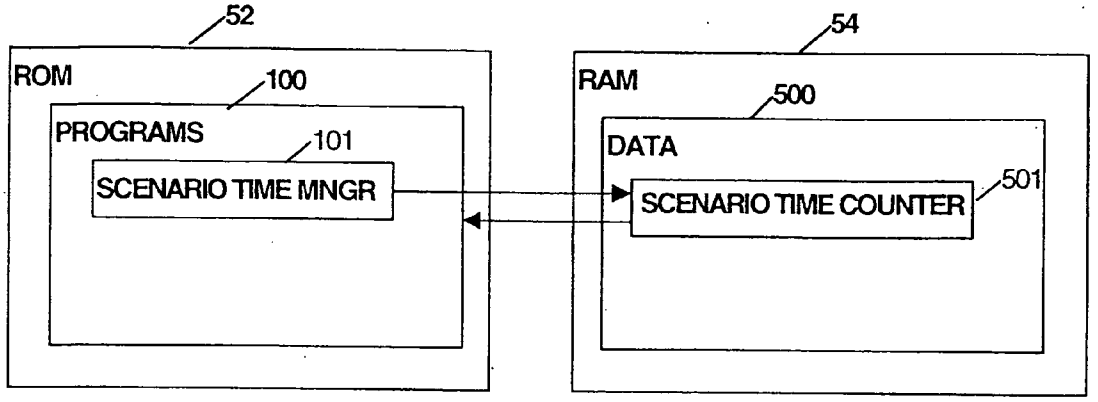

FIG. 3

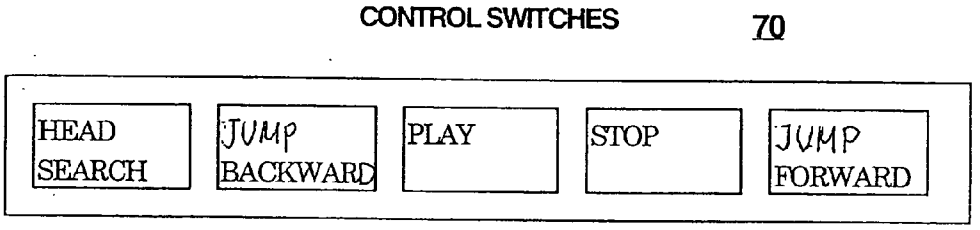

FIG. 4

OPERATED SWITCHES (or ISSUED COMMAND)	THE VALUE (Ct) OF SCENARIO TIME COUNTER
PLAY	Ct+1 FOR EVERY FRAME PERIOD T DURING EXECUTION
JUMP FORWARD (JF)	Ct+Cj AFTER THE COMMAND EXECUTION
JUMP BACKWARD (JB)	Ct−Cj AFTER THE COMMAND EXECUTION
HEAD SEARCH (HS)	0 AFTER THE COMMAND EXECUTION
STOP	Ct AFTER THE COMMAND EXECUTION

(Cj IS A PREDETERMINED LEAP (OR JUMP) DISTANCE FOR FORWARD AND BACKWARD OPERATIONS)

FIG. 5

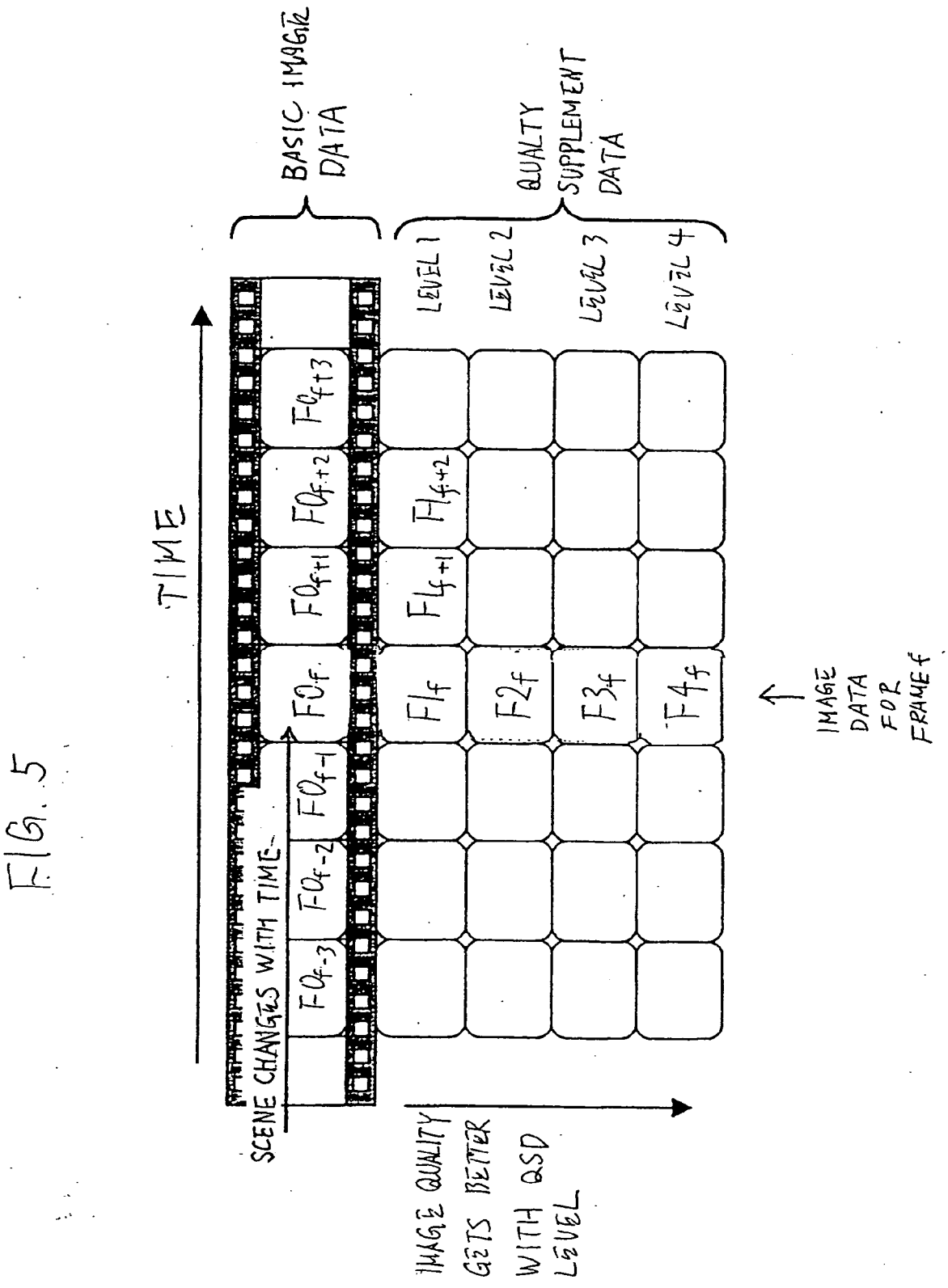
BASIC IMAGE DATA
QUALITY SUPPLEMENT DATA
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
TIME
SCENE CHANGES WITH TIME
IMAGE QUALITY GETS BETTER WITH QSD LEVEL
IMAGE DATA FOR FRAME f
F0f-3
F0f-2
F0f-1
F0f
F0f+1
F0f+2
F0f+3
F1f
F1f+1
F1f+2
F2f
F3f
F4f

FIG. 6

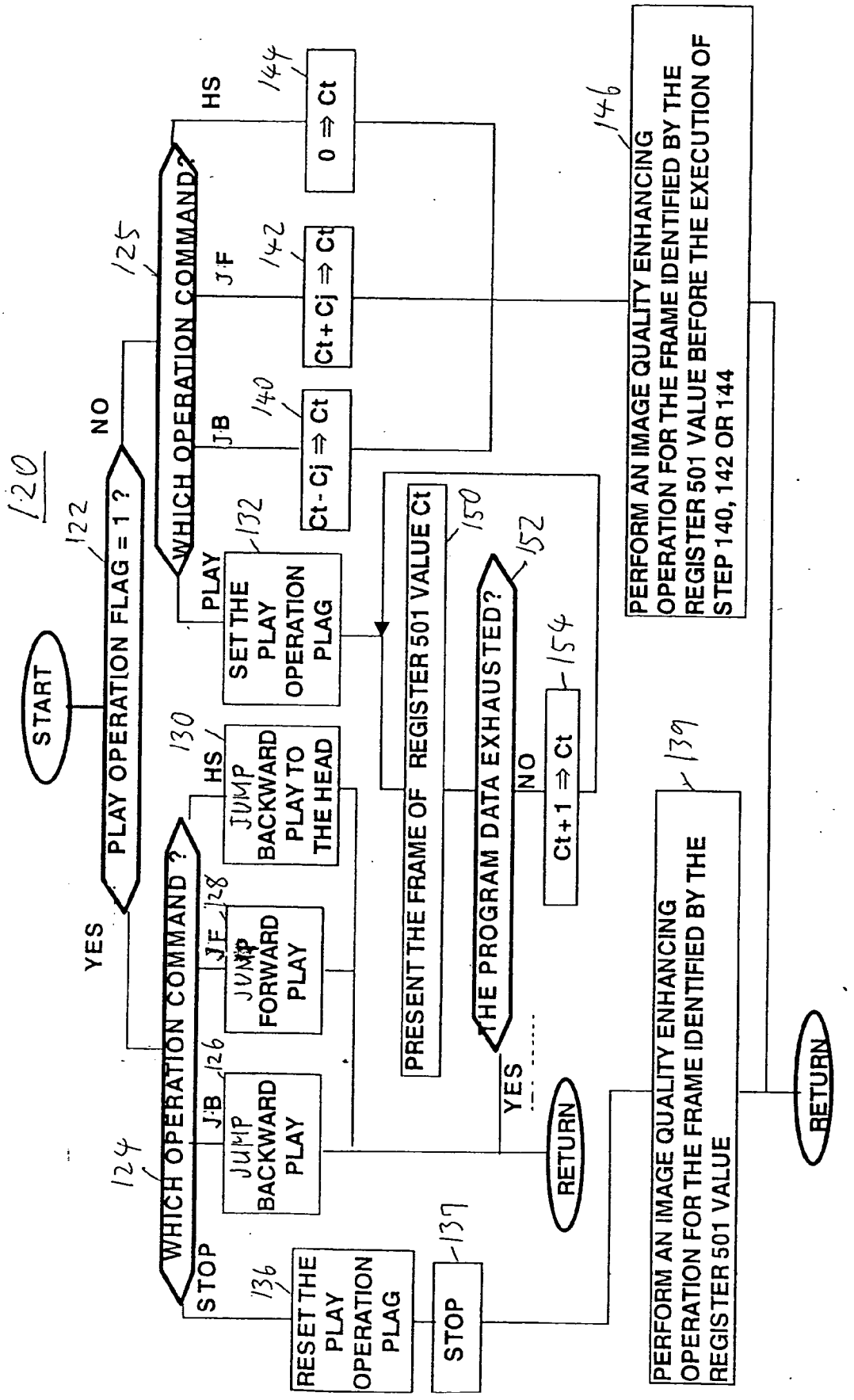
120
START
122
PLAY OPERATION FLAG = 1 ?
YES
NO
124
WHICH OPERATION COMMAND ?
STOP
JB
JUMP BACKWARD PLAY
126
JF
JUMP FORWARD PLAY
128
HS
JUMP BACKWARD PLAY TO THE HEAD
130
PLAY
SET THE PLAY OPERATION FLAG
132
125
WHICH OPERATION COMMAND?
HS
0 ⇒ Ct
144
JF
Ct + Cj ⇒ Ct
142
JB
Ct - Cj ⇒ Ct
140
PRESENT THE FRAME OF REGISTER 501 VALUE Ct
150
THE PROGRAM DATA EXHAUSTED?
152
YES
NO
Ct + 1 ⇒ Ct
154
RETURN
PERFORM AN IMAGE QUALITY ENHANCING OPERATION FOR THE FRAME IDENTIFIED BY THE REGISTER 501 VALUE BEFORE THE EXECUTION OF STEP 140, 142 OR 144
146
RESET THE PLAY OPERATION FLAG
136
STOP
137
PERFORM AN IMAGE QUALITY ENHANCING OPERATION FOR THE FRAME IDENTIFIED BY THE REGISTER 501 VALUE
139
RETURN

FIG. 8

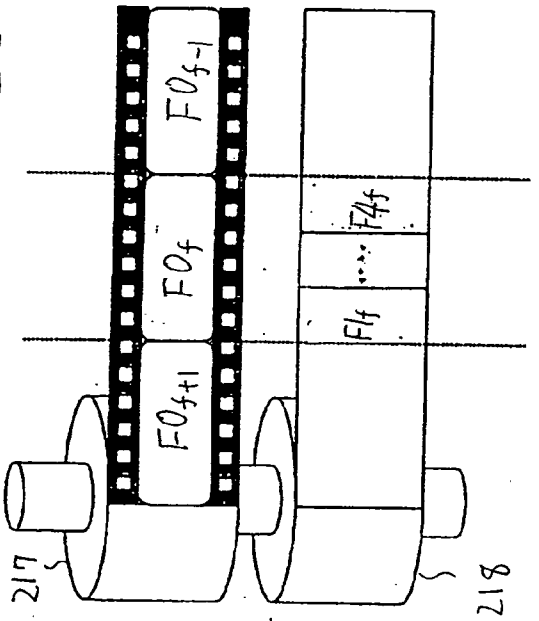
20b
FO$_{f-1}$
FO$_f$
FO$_{f+1}$
F1$_f$
F4$_f$
217
218

FIG. 7

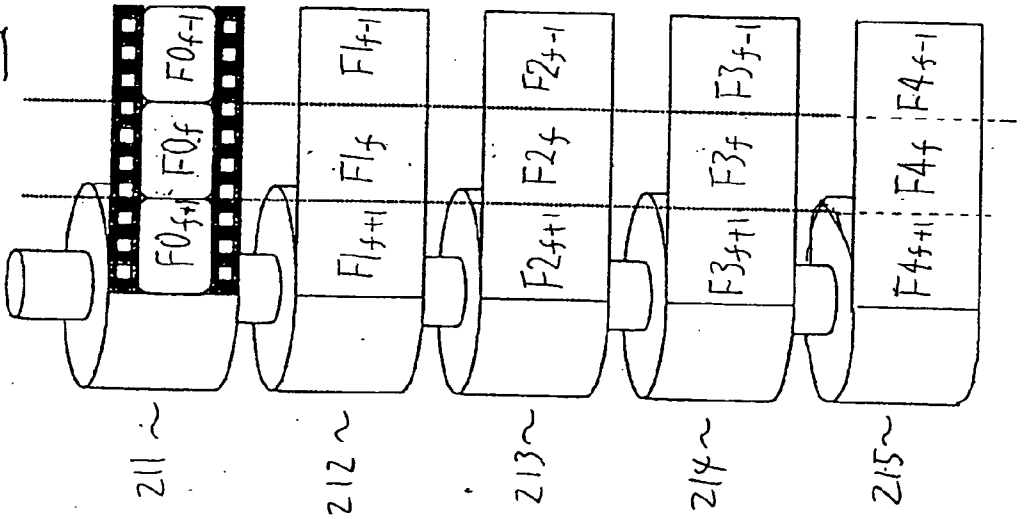
20a
FO$_{f-1}$
FO$_f$
FO$_{f+1}$
F1$_{f-1}$
F1$_f$
F1$_{f+1}$
F2$_{f-1}$
F2$_f$
F2$_{f+1}$
F3$_{f-1}$
F3$_f$
F3$_{f+1}$
F4$_{f-1}$
F4$_f$
F4$_{f+1}$
211
212
213
214
215

FIG. 9

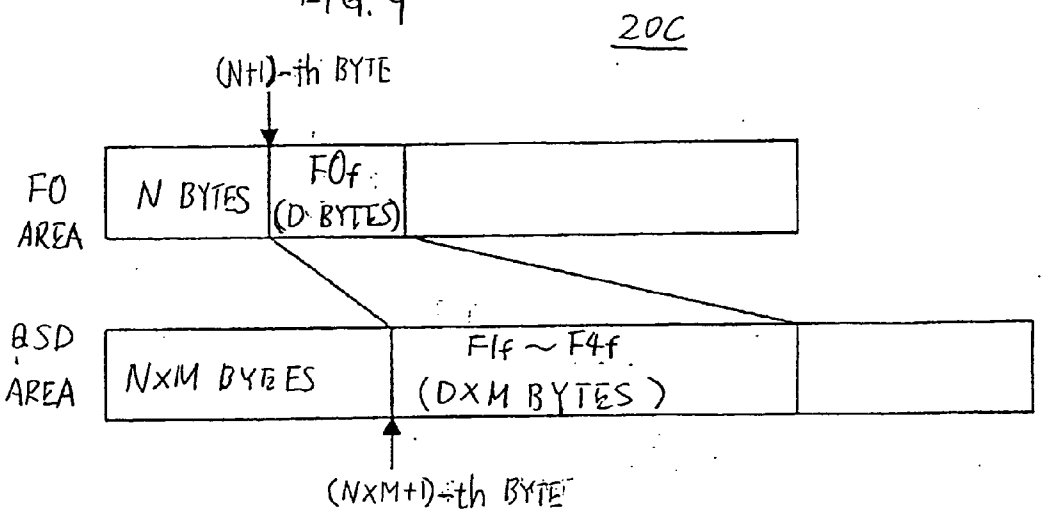

FIG. 11

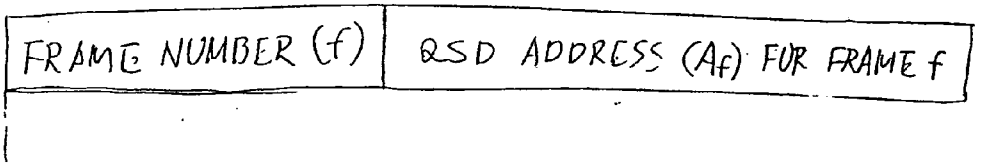

FIG. 10

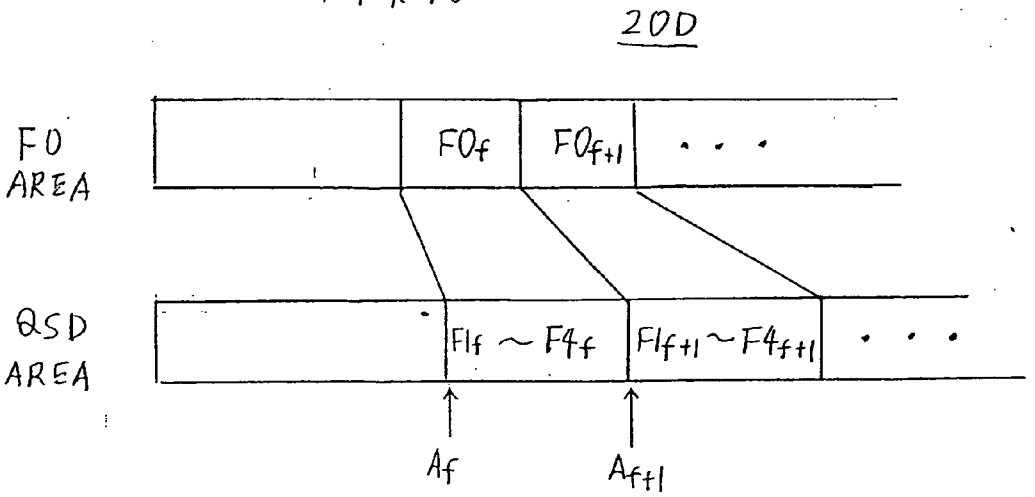

FIG. 12

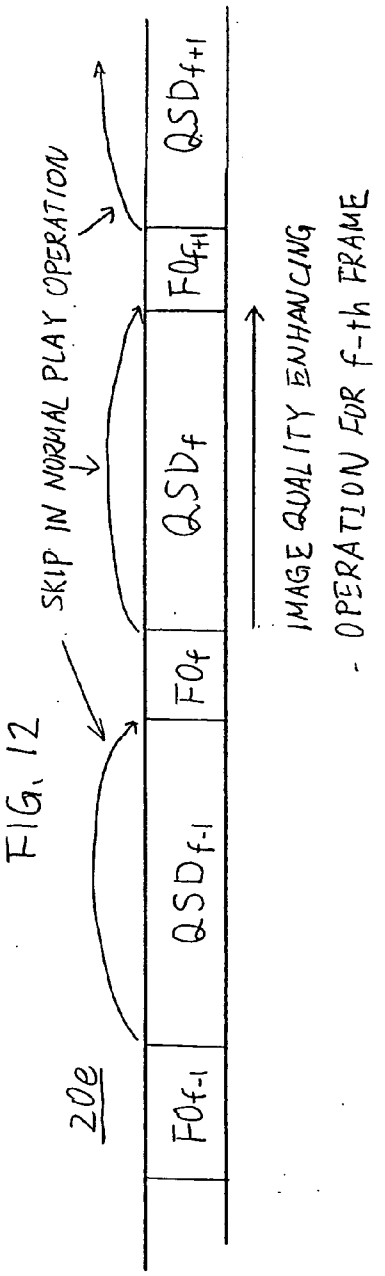
20e
FOf-1
QSDf-1
FOf
QSDf
FOf+1
QSDf+1
SKIP IN NORMAL PLAY OPERATION
IMAGE QUALITY ENHANCING
- OPERATION FOR f-th FRAME

FIG. 13

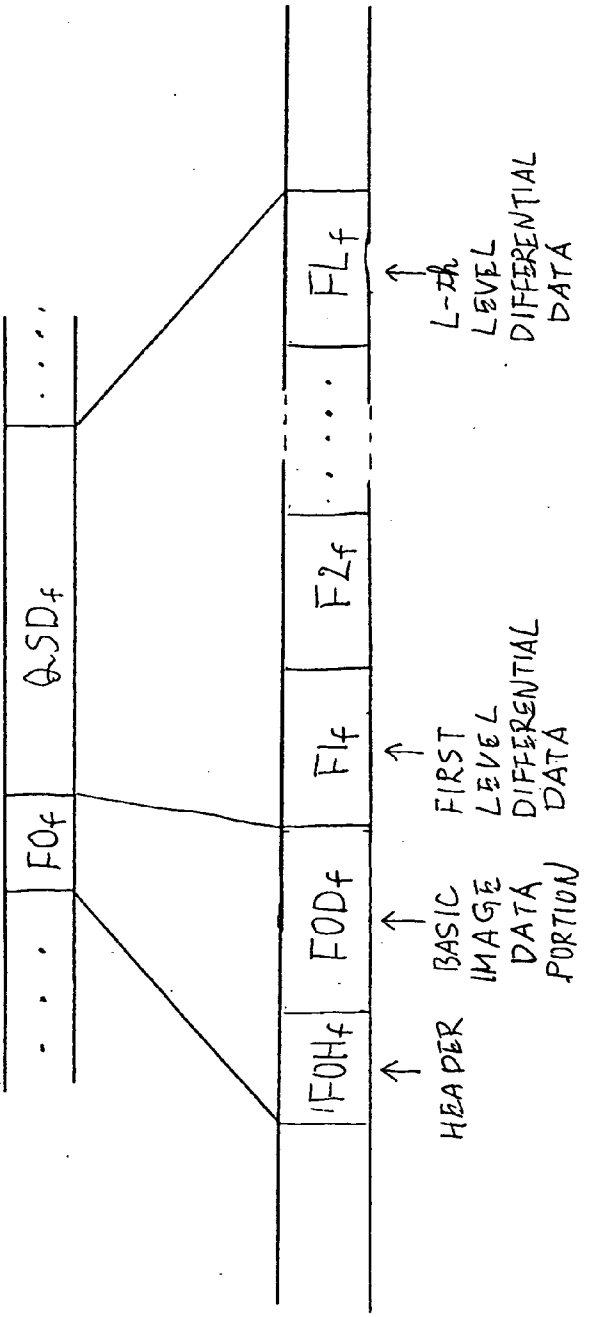
QSDf
FOf
FIf
F2f
FLf
IFOHf
FODf
HEADER
BASIC IMAGE DATA PORTION
FIRST LEVEL DIFFERENTIAL DATA
L-th LEVEL DIFFERENTIAL DATA

FIG. 14

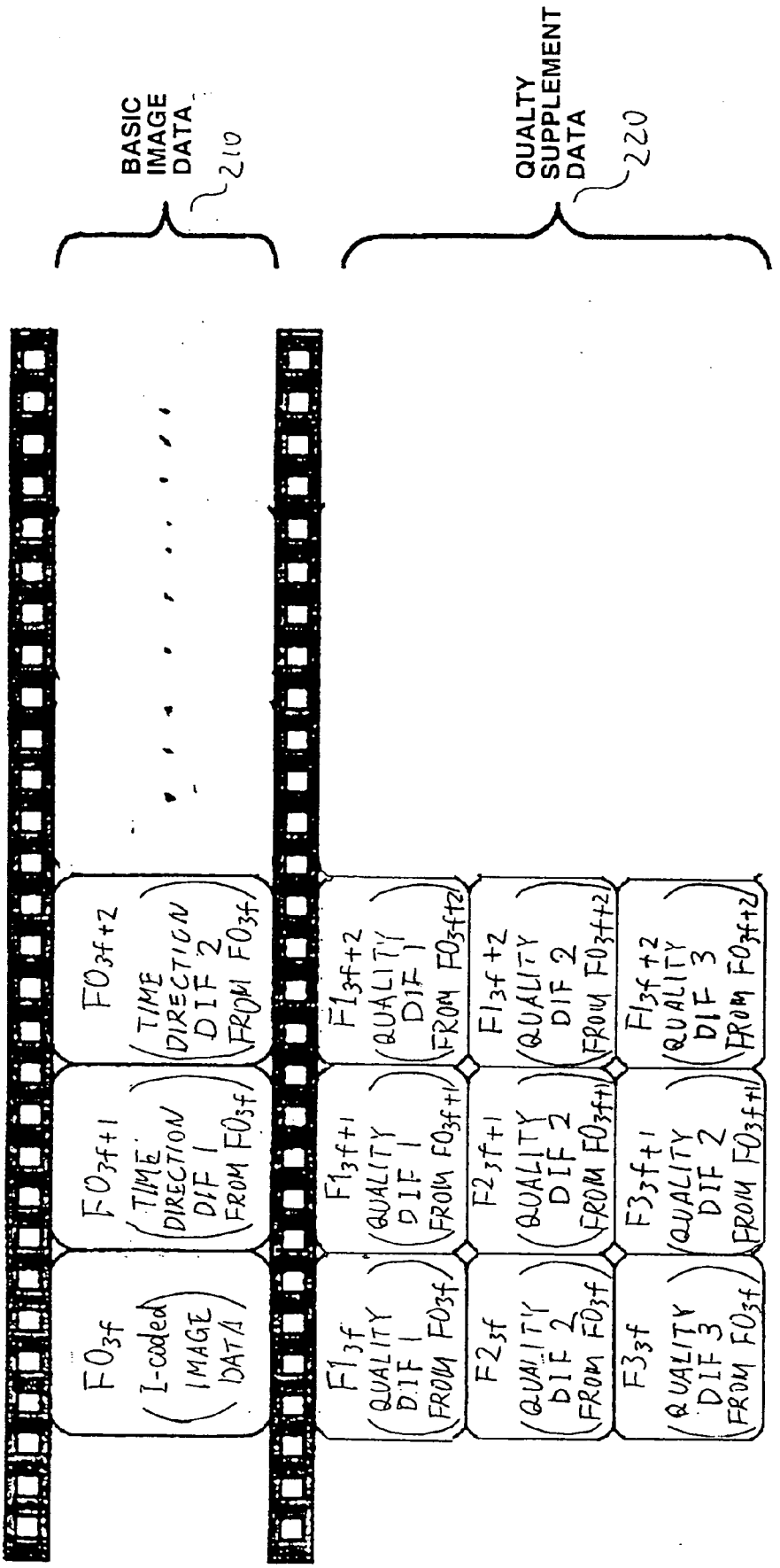
BASIC IMAGE DATA
210
QUALITY SUPPLEMENT DATA
220
FO_{3f} (I-coded IMAGE DATA)
FO_{3f+1} (TIME DIRECTION DIF 1 FROM FO_{3f})
FO_{3f+2} (TIME DIRECTION DIF 2 FROM FO_{3f})
$F1_{3f}$ (QUALITY DIF 1 FROM FO_{3f})
$F2_{3f}$ (QUALITY DIF 2 FROM FO_{3f})
$F3_{3f}$ (QUALITY DIF 3 FROM FO_{3f})
$F1_{3f+1}$ (QUALITY DIF 1 FROM FO_{3f+1})
$F2_{3f+1}$ (QUALITY DIF 2 FROM FO_{3f+1})
$F3_{3f+1}$ (QUALITY DIF 3 FROM FO_{3f+1})
$F1_{3f+2}$ (QUALITY DIF 1 FROM FO_{3f+2})
$F1_{3f+2}$ (QUALITY DIF 2 FROM FO_{3f+2})
$F1_{3f+2}$ (QUALITY DIF 3 FROM FO_{3f+2})

FIG. 15

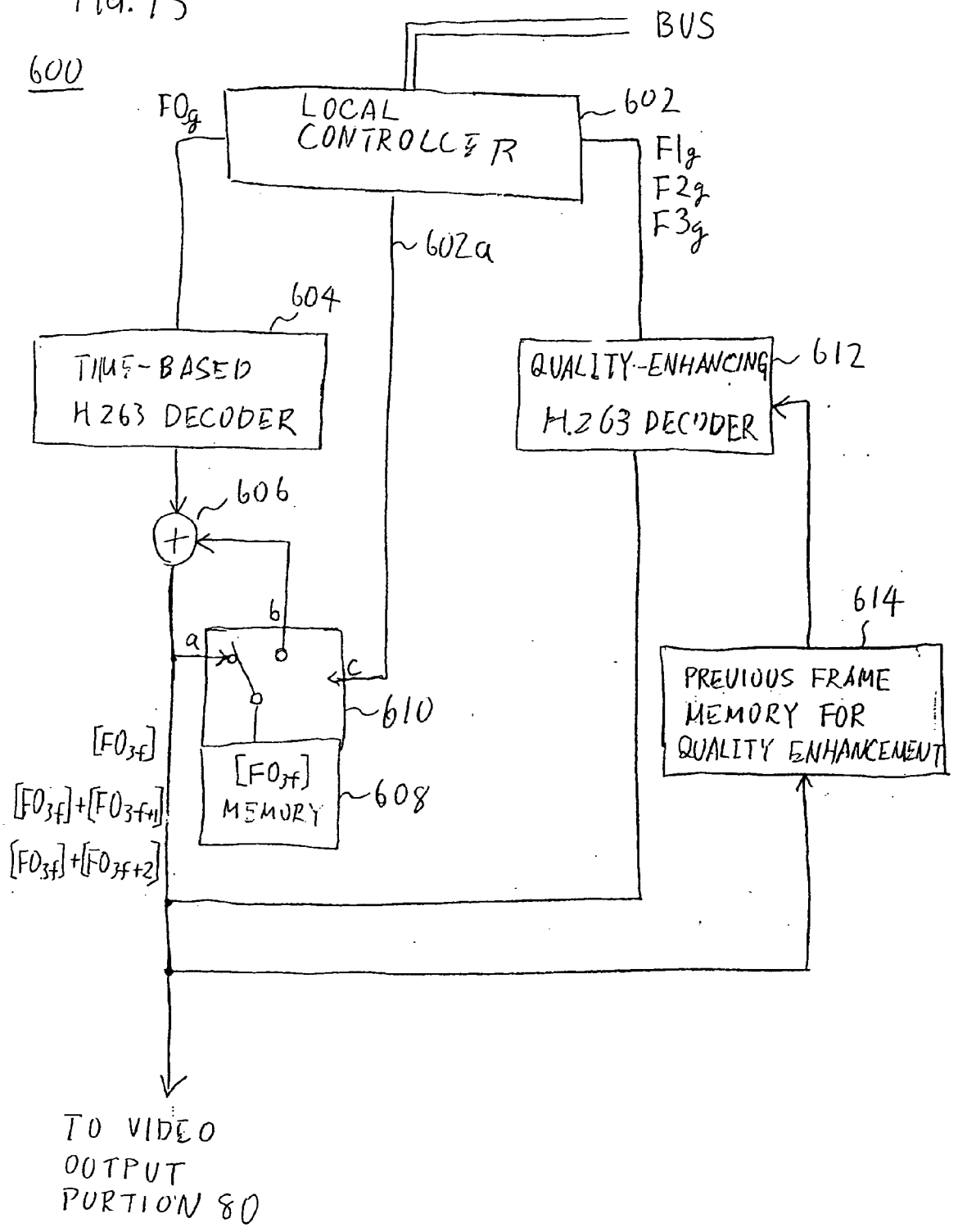
600
BUS
FO_g
LOCAL CONTROLLER
602
Fl_g
F2_g
F3_g
602a
604
TIME-BASED H263 DECODER
QUALITY-ENHANCING H.263 DECODER
612
606
b
a
c
610
[FO_3f]
[FO_3f]+[FO_3f+1]
[FO_3f]+[FO_3f+2]
[FO_3f] MEMORY
608
614
PREVIOUS FRAME MEMORY FOR QUALITY ENHANCEMENT
TO VIDEO OUTPUT PORTION 80

FIG. 16

SCENARIO DATA TABLE

OBJECT ID	KIND OF OBJECT	DISPLAY POSITION	DISPLAY SIZE	PRESENTATION START TIME (Ct VALUE = SCt)	PRESENTATION END TIME (Ct VALUE)
001	STILL	X=0, Y=0	800x600	0:00 (0)	3:25 (369000)
002	VIDEO	X=100, Y=100	400x300	0:00 (0)	3:25 (369000)
003	TEXT	X=20, Y=20	400x50	0:00 (0)	1:00 (108000)
004	TEXT	X=200, Y=500	500x50	1:00 (108000)	3:00 (324000)
005	STILL	X=600, Y=150	150x200	1:00 (108000)	2:00 (216000)
006	STILL	X=600, Y=450	100x100	2:30 (270000)	3:15 (351000)

FIG. 17

ACTIBE OBJECT TABLE

Ct VALUE	ACTIVE OBJECTS
0	001, 002, 003
108000	001, 002, 004, 005
216000	001, 002, 004
270000	001, 002, 004, 006
324000	001, 002, 006
351000	001, 002
369000	

FIG. 18

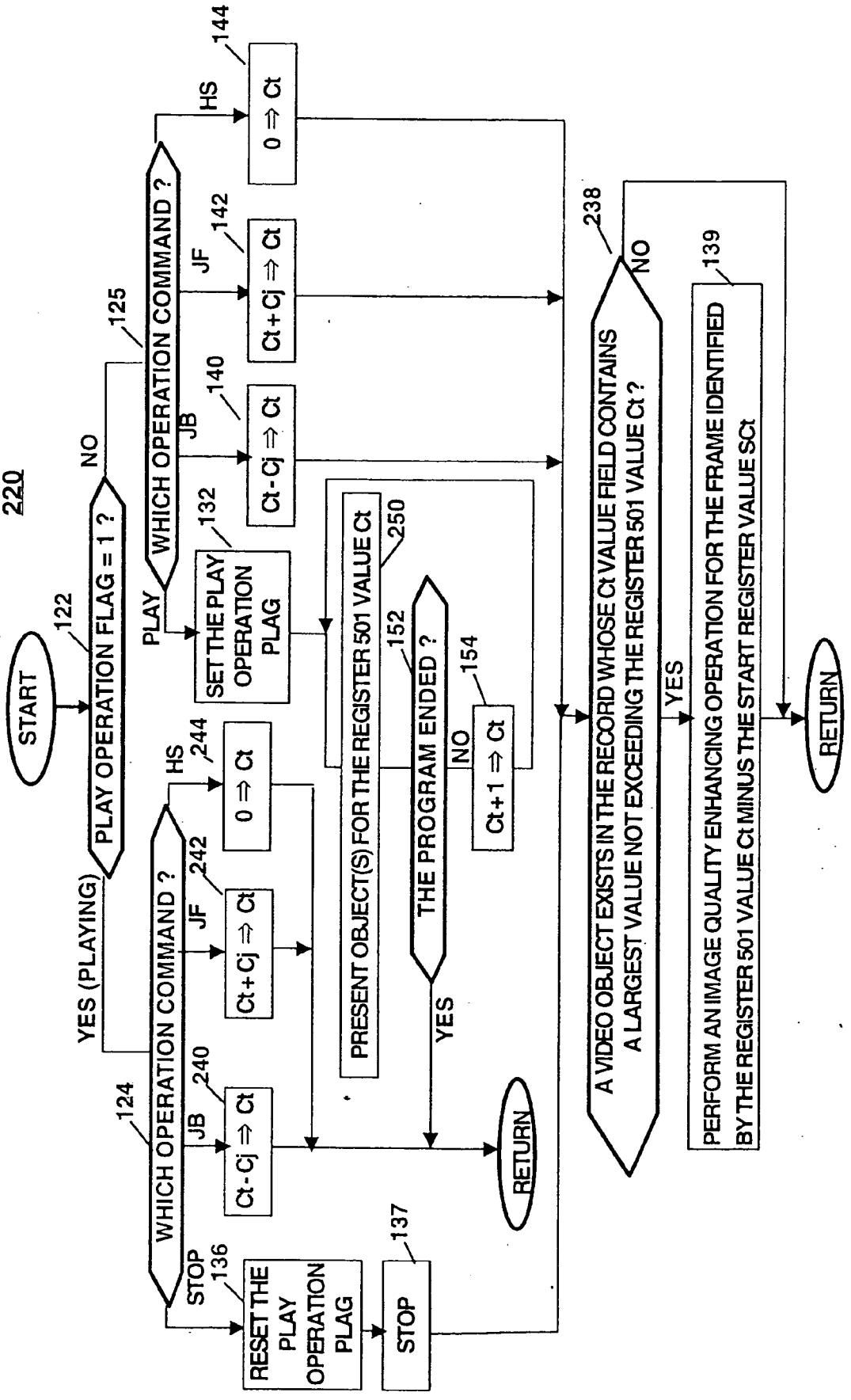
220
START
122
PLAY OPERATION FLAG = 1 ?
NO
YES (PLAYING)
125
WHICH OPERATION COMMAND ?
PLAY
SET THE PLAY OPERATION PLAG
132
HS
0 ⇒ Ct
144
JF
Ct+Cj ⇒ Ct
142
JB
Ct-Cj ⇒ Ct
140
PRESENT OBJECT(S) FOR THE REGISTER 501 VALUE Ct
250
THE PROGRAM ENDED ?
152
NO
Ct+1 ⇒ Ct
154
YES
RETURN
124
WHICH OPERATION COMMAND ?
HS
0 ⇒ Ct
244
JF
Ct+Cj ⇒ Ct
242
JB
Ct-Cj ⇒ Ct
240
STOP
RESET THE PLAY OPERATION PLAG
136
STOP
137
A VIDEO OBJECT EXISTS IN THE RECORD WHOSE Ct VALUE FIELD CONTAINS A LARGEST VALUE NOT EXCEEDING THE REGISTER 501 VALUE Ct ?
238
NO
YES
PERFORM AN IMAGE QUALITY ENHANCING OPERATION FOR THE FRAME IDENTIFIED BY THE REGISTER 501 VALUE Ct MINUS THE START REGISTER VALUE SCt
139
RETURN

FIG. 19

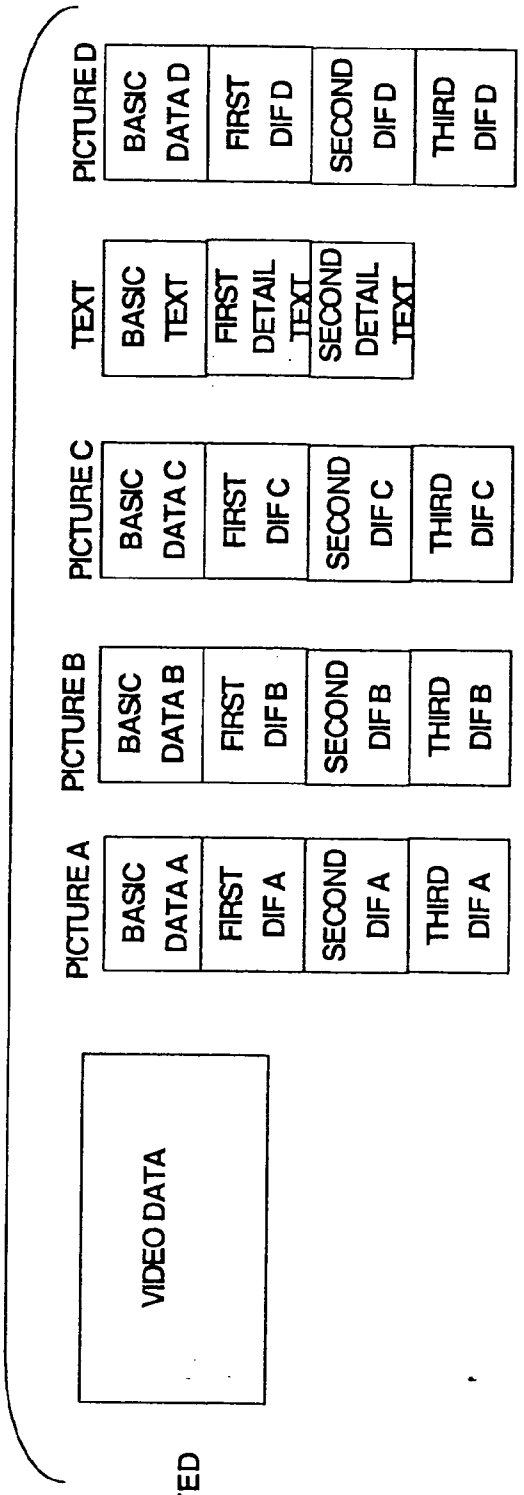
OBJECT DATA TO BE TRANSMITTED
VIDEO DATA
PICTURE A
BASIC DATA A
FIRST DIF A
SECOND DIF A
THIRD DIF A
PICTURE B
BASIC DATA B
FIRST DIF B
SECOND DIF B
THIRD DIF B
PICTURE C
BASIC DATA C
FIRST DIF C
SECOND DIF C
THIRD DIF C
TEXT
BASIC TEXT
FIRST DETAIL TEXT
SECOND DETAIL TEXT
PICTURE D
BASIC DATA D
FIRST DIF D
SECOND DIF D
THIRD DIF D

FIG. 20

SCENARIO
STOP COMMAND
SCENARIO TIME COUNT Ct
VIDEO DATA
PICTURE A
PICTURE B
PICTURE C
TEXT
PICTURE D

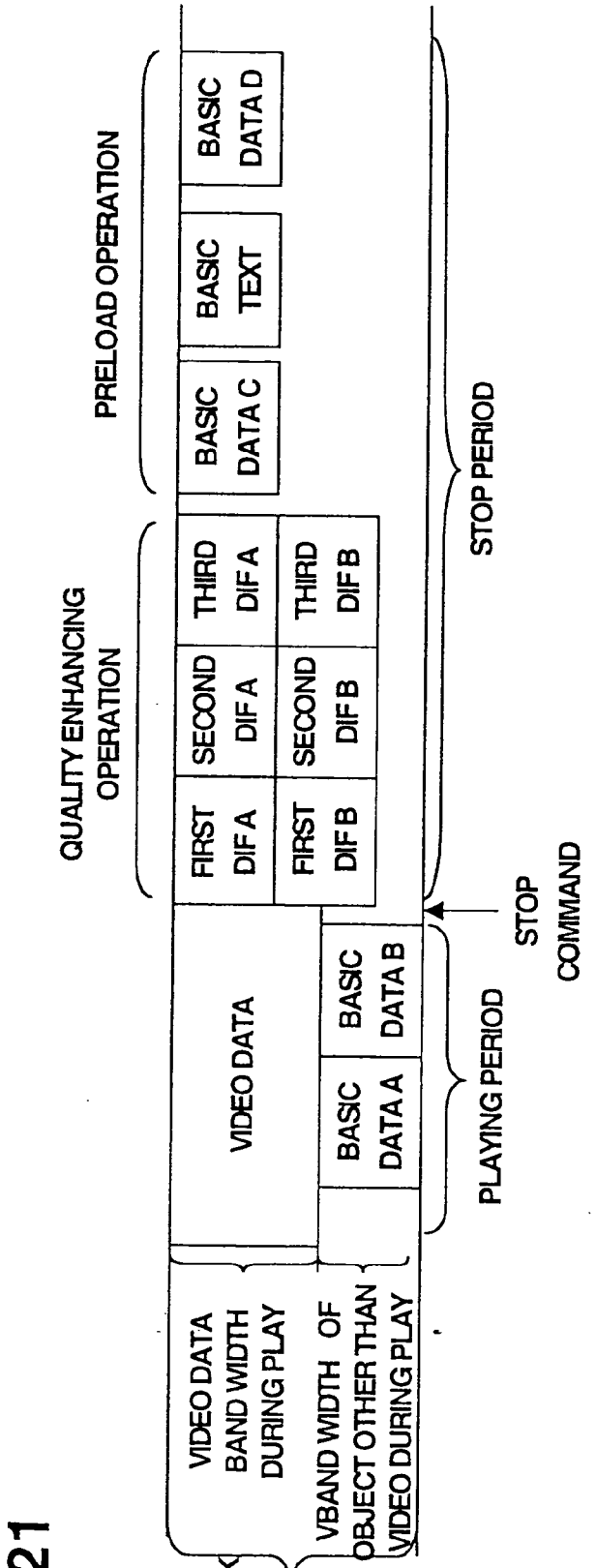
NETWORK BAND WIDTH
VIDEO DATA BAND WIDTH DURING PLAY
VBAND WIDTH OF OBJECT OTHER THAN VIDEO DURING PLAY
VIDEO DATA
BASIC DATA A
BASIC DATA B
FIRST DIF A
SECOND DIF A
THIRD DIF A
FIRST DIF B
SECOND DIF B
THIRD DIF B
BASIC DATA C
BASIC TEXT
BASIC DATA D
QUALITY ENHANCING OPERATION
PRELOAD OPERATION
PLAYING PERIOD
STOP COMMAND
STOP PERIOD

FIG. 21

FIG. 22

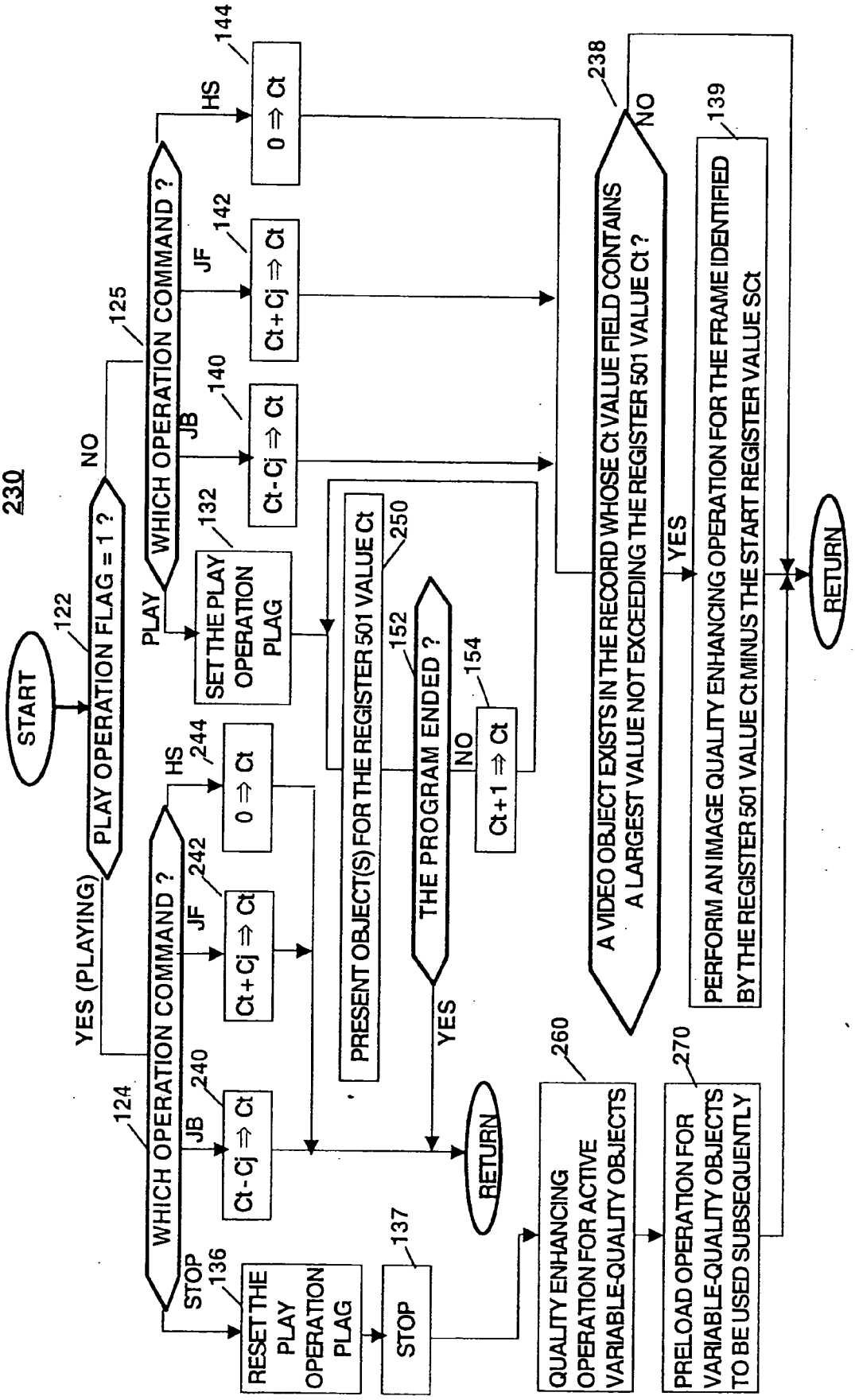
230
START
122
PLAY OPERATION FLAG = 1 ?
NO
YES (PLAYING)
125
WHICH OPERATION COMMAND ?
PLAY
SET THE PLAY OPERATION PLAG
132
HS
0 ⇒ Ct
144
JF
Ct+Cj ⇒ Ct
142
JB
Ct-Cj ⇒ Ct
140
PRESENT OBJECT(S) FOR THE REGISTER 501 VALUE Ct
250
THE PROGRAM ENDED ?
152
NO
Ct+1 ⇒ Ct
154
YES
RETURN
124
WHICH OPERATION COMMAND ?
HS
0 ⇒ Ct
244
JF
Ct+Cj ⇒ Ct
242
JB
Ct-Cj ⇒ Ct
240
STOP
RESET THE PLAY OPERATION PLAG
136
STOP
137
A VIDEO OBJECT EXISTS IN THE RECORD WHOSE Ct VALUE FIELD CONTAINS A LARGEST VALUE NOT EXCEEDING THE REGISTER 501 VALUE Ct ?
238
NO
YES
PERFORM AN IMAGE QUALITY ENHANCING OPERATION FOR THE FRAME IDENTIFIED BY THE REGISTER 501 VALUE Ct MINUS THE START REGISTER VALUE SCt
139
QUALITY ENHANCING OPERATION FOR ACTIVE VARIABLE-QUALITY OBJECTS
260
PRELOAD OPERATION FOR VARIABLE-QUALITY OBJECTS TO BE USED SUBSEQUENTLY
270
RETURN

FIG. 23

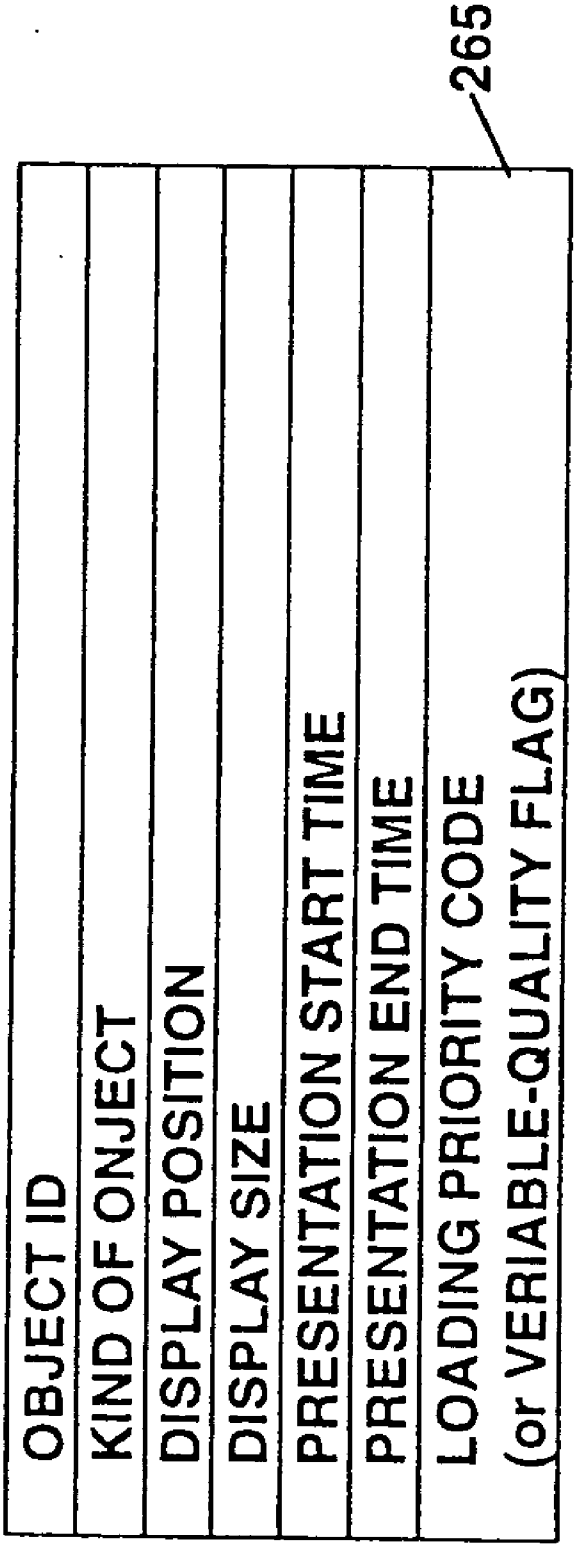
265
OBJECT ID
KIND OF ONJECT
DISPLAY POSITION
DISPLAY SIZE
PRESENTATION START TIME
PRESENTATION END TIME
LOADING PRIORITY CODE
(or VERIABLE-QUALITY FLAG)

FIG. 24


OBJECT ID
LOAD FLAG

CLIENT/SERVER MULTIMEDIA PRESENTATION SYSTEM

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates to a client/server system in which a client terminal connected with a server through a transmission path of a limited bandwidth plays a multimedia program which is stored in the server and is comprised of multimedia objects such as moving pictures, still pictures, sounds and texts while reading the objects in real time from the server.

[0003] 2. Description of the Prior Art

[0004] In such a system, a user of a client terminal is permitted to select one of a plurality of programs and to enter commands such as a play, a stop, a head search, a jump forward and a jump backward for the selected program. During a play operation, the server reads data of a specified program stored in a storage device and transmits the read data to the client terminal. Then, the client terminal displays the received data. However, once one of the stop, the head search, a jump forward and a jump backward command is executed, no data is transmitted from the server to the client terminal till the play command is executed.

[0005] The transmission rate of the transmission path between the server and each terminal is limited, i.e., the quantity of data transmitted for a certain period of time is limited. For this reason, in order to enable each client terminal to play a program whose data is stored in the server while having the program data transmitted from the server, video data of each program is stored in the server such that the bit rate (or the quantity of data reproduced or played per second) of video data of each program does not exceed the transmission rate of the transmission paths.

[0006] If the transmission paths between the server and the client terminals are considerably low as in case of ordinary telephone lines, it is necessary to reduce the frame rate, the resolution and/or the frame size, which degrades the picture quality of video objects.

[0007] It is an object of the invention to provide a video-on-demand system that enhances the quality of image by using the period of a play stoppage.

SUMMARY OF THE INVENTION

[0008] According to an aspect of the invention, a method of presenting, at a client terminal, a video program stored in a server linked with the client terminal via transmission path of a limited band width is provided. Each frame of the video program comprises a basic data portion and at least one level of quality supplement data portions. In the method, in response to one of play control commands from a user, the client terminal determines a start (or play) position in the video program according to the issued play control command. The play control commands includes a play, a stop, a head search, a jump forward and a jump backward command. In response to the issued play command, the terminal obtains and uses the basic data portions for playing the video program. In response to the stop command, the terminal obtains and uses the at least one level of quality supplement data portions of a last displayed frame for displaying a quality-enhanced version of the last displayed frame.

[0009] According to another aspect of the invention, a method of presenting, at a client terminal, a multimedia program stored in a server is provided. The multimedia program includes a video object. Each frame of the video object comprises a basic data portion and at least one level of detailed data portions. In this method, in response to one of play control commands from a user, the terminal determines a time count in the multimedia program according to the issued play control command. The play control commands include a play, a stop, a head search, a jump forward and a jump backward command. In response to one of the head search, the jump forward and the jump backward commands issued during a stop period, the terminal determines whether there is a video object to be displayed at the time count in the multimedia program. In the event there is the video object to be displayed at the time count in the multimedia program, the terminal obtains at least one level of quality supplement data portions for a first frame to be displayed in a next, play operation for displaying a quality-enhanced version of the first frame to be displayed.

[0010] If a stop command is issued, a test is responsively made to see if there is multimedia objects which are other than video objects and each comprise basic data and quality supplement data and which are to be displayed at said time count in said multimedia program. If so, then for each of said found multimedia objects, the terminal obtains the quality supplement data for displaying a quality-enhanced version of each object.

[0011] Alternatively, in response to the stop command, a test is made to see if there is (or are) multimedia objects which are other than video objects and each comprise basic data and quality supplement data and which are to be displayed later. If so, the terminal tries to obtain the basic data for as many of the found multimedia objects as possible in advance.

[0012] According to another aspect of the invention, a terminal for presenting a video program stored in a remote server connected therewith via band-limited transmission path is provided. Each frame of the video program comprises a basic data portion and at least one level of quality supplement data portions. The terminal comprises means, responsive to one of play control commands from a user, for determining a start position in the video program according to the issued play control command. The play control command includes a play, a stop, a head search, a jump forward and a jump backward command. The terminal includes means, responsive to the play command from the user, for obtaining and using said basic data portions for playing said video program; and means, responsive to the stop command, for obtaining and using at least one level of quality supplement data portions of a last displayed frame for displaying a quality-enhanced version of the last displayed frame.

BRIEF DESCRIPTION OF THE DRAWING

[0013] The features and advantages of the present invention will be apparent from the following description of an exemplary embodiment of the invention and the accompanying drawing, in which:

[0014] **FIG. 1** is a schematic block diagram showing an arrangement of a multimedia-on-demand system that can embody the present invention in various forms;

[0015] **FIG. 2** is a schematic diagram showing the contents of the ROM **52** and the RAM;

[0016] **FIG. 3** is a diagram showing exemplary presentation control buttons included in the control switches **70** of **FIG. 1**;

[0017] **FIG. 4** is a table for describing how the scenario time manager **101** sets the value Ct of the scenario time register **501** in response to the executed presentation control command;

[0018] **FIG. 5** is a diagram conceptually showing a data structure of a video object stored in the mass storage **20** of **FIG. 1**;

[0019] **FIG. 6** is a flowchart showing an exemplary operation of an interrupt subroutine called from a main program in response to an interrupt caused by a pressing of one of the presentation control buttons of **FIG. 3** after one of the available programs stored in the mass storage **20** is specified by the user at the client terminal **3**;

[0020] **FIGS. 7 and 8** are diagrams conceptually showing arrangements of a first and a second exemplary mass storage **20***a* and **20***b* using tape storage devices;

[0021] **FIGS. 9 and 10** are diagrams showing a first storing scheme **20***c* and a second storing scheme **20***d* of storing a video object on a disc storage device;

[0022] **FIG. 11** is a diagram showing an address table used in the second storing scheme **20***d* of **FIG. 10**;

[0023] **FIG. 12** is a diagram showing a third storing scheme **20***e* of storing a video object on a disc storage device;

[0024] **FIG. 13** is a diagram showing a data structure obtained when a progressive JPEG video object is stored in the third storing scheme **20***e* as shown in **FIG. 12**;

[0025] **FIG. 14** is a diagram conceptually showing the H.263 video format;

[0026] **FIG. 15** is a schematic block diagram showing an exemplary arrangement of a video decoder **600** which is included in the video & audio decoder **60** of **FIG. 1** and which is adapted to decode a video object of the H.263 format as shown in **FIG. 14**;

[0027] **FIG. 16** is a diagram showing an exemplary scenario data table of a multimedia program available in a multimedia-on-demand system according to a second illustrative embodiment of the invention:

[0028] **FIG. 17** is a diagram showing an exemplary active object table created from the scenario data table of **FIG. 16**;

[0029] **FIG. 18** is a flowchart showing an operation of an interrupt subroutine called from a main program in response to an interrupt caused by the user at the client terminal **3** pressing one of the presentation control buttons of **FIG. 3** after specifying one of the available multimedia programs stored in the mass storage **20**;

[0030] **FIG. 19** is a diagram showing various variable-quality objects used in an exemplary multimedia program available in the inventive multimedia-on-demand system;

[0031] **FIG. 20** is a diagram showing how the multimedia objects of **FIG. 19** are presented in the exemplary multimedia program;

[0032] **FIG. 21** is a diagram showing a way of transmitting the multimedia objects to present the objects as shown in **FIG. 20**;

[0033] **FIG. 22** is a flowchart showing an operation of an interrupt subroutine called in response to a pressing of one of the presentation control buttons of **FIG. 3** according to the third embodiment of the invention;

[0034] **FIG. 23** is a diagram showing an exemplary structure of a scenario data table according to the third embodiment of the invention; and

[0035] **FIG. 24** is a diagram showing an exemplary arrangement of a load flag storage location.

[0036] Throughout the drawing, the same elements when shown in more than one figure are designated by the same reference numerals.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0037] **FIG. 1** is a schematic block diagram showing an arrangement of a multimedia-on-demand system that can embody the present invention in various forms. In **FIG. 1**, double lines indicate bus lines. The multimedia-on-demand system comprises a server **1** that stores and serves multimedia programs, at least one client terminal **3** that plays one of the multimedia programs, and a network **2** for connecting the server **1** and the client terminals **3**.

[0038] The server **1** comprises a controller **10**, a mass storage **20** for storing the multimedia programs, an object data transmitter **30** for transmitting object data constituting a multimedia program and a control data communication interface (IF) **40** for communicating control data with each client terminal **3**. The client terminal **3** comprises an object data receiver **35** for receiving object data transmitted from the server **1**; a control data communication IF **40** for communicating the control data with the server **1**; a controller **50** for controlling the operation of the terminal **3**; a video and audio decoder **60** for decoding video and audio object data into video and audio output signals; a video output portion **80** for providing a video output according to the video signal from the decoder **60** and the image data from the controller **50**; a audio output portion **90** for providing an audio output according to the audio signal from the decoder **60** and the audio data from the controller **50**; and control switches **70** that permit the user to specify a desired one of the multimedia programs stored in the mass storage **20** and to enter a play, stop, jump forward, jump backward and head search commands. The controller **50** includes a read only memory (ROM) **52** and a random access memory (RAM) **54**. The elements **35**, **40**, **50**, **60**, **70**, **80** and **90** are interconnected by bus lines **51**.

[0039] **FIG. 2** is a schematic diagram showing the contents of the ROM **52** and the RAM. In **FIG. 1**, the ROM **52** stores programs **100** necessary for the operation of the controller **50**. The RAM **54** stores various data **500** necessary for the operation of the controller **50**. The programs **100** include a scenario time manager **101**, which sets the value (Ct) of a scenario time register **501** in the RAM **54** in a play

operation of a multimedia program such that the current scenario time or the current position in the multimedia program is given by T*Ct, where T is a frame period of the video objects.

[0040] The control switches **70** include presentation control buttons for head search (HS), jump forward (JF), play, stop, jump backward (JB) operations as shown in **FIG. 3**. **FIG. 4** shows a table for describing how the scenario time manager **101** sets the value Ct of the scenario time register **501** in response to the executed presentation control command. In **FIG. 4**, if a play command is issued, the scenario time manger **101** increments the value Ct of the scenario time register **501** for every frame period T as long as the play command is active. If a jump forward, a jump backward or a head search is issued, the scenario time manger **101** sets the scenario time register value Ct to Ct+Cj, Ct−Cj or 0, respectively. Cj is a predetermined jump distance for use in the JF and JB operations. In case of a stop command, the scenario time manger **101** does nothing, i.e., the value Ct remains unchanged.

[0041] Each of the multimedia programs generally comprises video objects, still picture objects, audio objects and/or text objects.

Embodiment 1

[0042] For the sake of simplicity, it is assumed in a first illustrative embodiment of the invention that the multimedia-on-demand system of **FIG. 1** is a video-on-demand system, i.e., each of the programs available at each client comprises a video object.

[0043] It is also assumed that the data of the video object stored in the mass storage **20** has a structure as shown in **FIG. 5**. Data of each frame of the video object (hereinafter referred to as "each frame data Ff") comprises a basic image data portion F**0***f* and at least one level (e.g., 4 levels in **FIG. 5**) of quality supplement data portions F**1***f*, F**2***f*, F**3***f* and so on. (f=1, 2, . . . , N, where N is the total number of frames of a video object) The suffix f is the frame number of the frame. Zero "0" following "F" in a label given to each data portion indicates that the data portion is the basic image data. A non-zero numeral (1, 2, 3 . . .) following "F" in a label given to each data portion indicates that the data portion is quality supplement data of the level specified by the non-zero numeral. The image quality of the f-th frame becomes better to the best by using not only basic image data F**0***f* but also quality supplement data F**1***f*, F**2***f*, F**3***f* and so on. In the following description, it is assumed that there are 4 levels of quality supplement data portions F**1***f*, F**2***f*, F**3***f* and F**4***f* for each frame.

[0044] In the first illustrative embodiment, the client terminal **3** uses only the basic image data $F0_1$, $F0_2$, . . . , $F0_N$ (hereinafter referred, en bloc, to like "F0") in a play operation. However, if the terminal **3** detects a stop command in an arbitrary state of operations or detects one of head search (HS), jump forward (JF) and jump backward (JB) commands during a stop state, the terminal **3** performs a image quality enhancing operation on entering a stop state or just after the operation of the detected command by obtaining the quality supplement data F**1***f*, F**2***f*, F**3***f* and F**4***f* for the last displayed frame from the server **1**.

[0045] Since the presented program is a video object in this example, the scenario time register **501** contains the frame number f, that is, Ct=f.

[0046] **FIG. 6** is a flowchart showing an operation executed by the controller **50** of the client terminal **3** under the control of an interrupt subroutine called from a main program in response to an interrupt caused by the user at the client terminal **3** pressing one of the presentation control buttons of **FIG. 3** after specifying one of the available programs stored in the mass storage **20**. In **FIG. 6**, the controller **50** first make s a test in step **122** to see if a play operation flag (not shown) is logical "1" or indicates that the terminal is in one of the play modes: i.e., a (normal) play, a jump forward (JF) play, a jump backward (JB) play, and a head search (HS) play (or a JB play to the beginning of the program). If so (which means that the terminal **3** is in a play mode), a test is made in step **124** to see which presentation control command has been issued.

[0047] If JB, JF or HS command is detected in step **124**, then the controller **50** executes a JB play step **126**, a JF play step **128** or a HS play step **130**, respectively, in a well known manner; and returns to the main program that has invoked this subroutine **120** to resume the play operation that was being executed when this routine **120** was invoked. If the stop command is detected in step **124**, the controller **50** resets the play operation flag, i.e., sets the flag logical "0" in step **136**; ceases the play mode in step **137**; performs an image quality enhancing operation for the frame identified by the value Ct (=f in this example) of the scenario time register **501** in step **139**; and ends the operation **120**.

[0048] Specifically, in step **139**, the controller **50** transmits an image quality enhancing instruction and the register **501** value f to the server **1**. The controller **10** of the server **1** responsively reads the quality supplement data F**1***f*, F**2***f*, F**3***f* and F**4***f* for the frame identified by the value f from the mass storage **20** and transmits them to the requesting client terminal **3**. The terminal **3** responsively adding the received quality supplement data F**1***f*, F**2***f*, F**3***f* and F**4***f* to the basic image data F**0***f* into a high quality frame data. By doing this, the quality of the currently displayed frame becomes better gradually with the receptions of the quality supplement data F**1***f*, F**2***f*, F**3***f* and F**4***f*. After step **146**, the controller **50** ends the operation **120**.

[0049] If the play operation flag is not logical "1" (which means that the terminal **3** is in a stop mode), a test is made in step **125** to see which presentation control command has been issued.

[0050] If a play command is detected in step **125**, the controller **50** sets the play operation flag logical "1" in step **132**; and plays (or reproduces) the current program (the program the user has specified before the controller **50** has entered the operation **120**) from the frame identified by the register **501** value Ct in steps **150**, **152** and **154**. Specifically, the controller **50** presents the frame of the register **501** value Ct in step **150** and checks the value Ct to see if the register value Ct has reached a preset end value in step **152**. If not, the controller **50** increments the value Ct in step **154** and goes back to step **150**. If the register **501** value Ct has reached the preset end value in step **152**, then the controller **50** returns to the main program that has invoked this subroutine **120**.

[0051] If JB, JF or HS command is detected in step **125**, then the controller **50** sets the register **501** value Ct to Ct−Cj, Ct+Cj or 0 in a JB step **140**, a JF step **142** or a HS step **144**, respectively, as shown in **FIG. 4**. After step **140**, **142** or **144**,

the controller **50** performs an image quality enhancing operation for the frame identified by the scenario time register **501** value before the execution of step **140**, **142** or **144** in step **146**. This causes the quality of the currently displayed frame to get better gradually with the receptions of the quality supplement data F1*f*, F2*f*, F3*f* and F4*f* as described above. The controller **50** ends the operation **120** after step **146**.

[**0052**] Some Examples of the Mass Storage **20**

[**0053**] **FIGS. 7 and 8** are diagrams conceptually showing arrangements of a first and a second exemplary mass storage **20***a* and **20***b* using tape storage devices. The storage **20***a* comprises five tape storage devices **211** through **215**. The tape device **211** stores the basic image data F**0**. The four tape devices **212** through **215** store the four level quality supplement data F**1** through F**4**, respectively. The basic image data F**0***f* and the corresponding quality supplement data F1*f*, F2*f*, F3*f* and F4*f* for each frame are recorded on the same tape positions of the five tapes. The five tape storage devices are so arranged that the five reels are independently rotated only in case of image quality enhancing operation and are synchronously rotated otherwise. In an image quality enhancing operation, the tape storage devices **212** through **215** for the quality supplement data F**1** through F**4** are sequentially read one by one.

[**0054**] The storage **20***b* comprises two tape storage devices **217** and **218**. The tape device **217** stores the basic image data F**0** The tape device **218** stores the four level quality supplement data F**1** through F**4**. The quality supplement data F1*f*, F2*f*, F3*f* and F4*f* for each frame are recorded on the tape position of the tape **218** which corresponds to the position of the tape **217** on which the basic image data F**0***f* for the frame is recorded when the tapes **217** and **218** are rotated synchronously. The two tape devices **217** and **218** are so arranged that the two reels are independently rotated only in case of image quality enhancing operation and are synchronously rotated otherwise. In an image quality enhancing operation, the tape storage device **218** portion for the quality supplement data F1*f* through F4*f* are sequentially read.

[**0055**] **FIGS. 9 and 10** show a first storing scheme **20***c* and a second storing scheme **20***d* of storing a video object on the mass storage **20**. The mass storage **20** may be any suitable disc storage device such as a hard disc, various optical discs, etc. The basic image data F**0** and the quality supplement data (QSD) F**1**, F**2**, . . . are stored in two different areas: a F**0** area and a QSD area on the third mass storage media.

[**0056**] In the first storing scheme **20***c* of **FIG. 9**, it is assumed that the quantity of the quality supplement data (QSD) F1*f*, F2*f*, F3*f* and F4*f* for each frame is M times the data quantity of the basic image data F0*f* for the frame, where M is a positive constant. Then, if the first data of the basic image data F0*f* is (N+1)-th byte in the F**0** area, then in order to obtain the quality supplement data F1*f*, F2*f*, F3*f* and F4*f*, the controller **40** has only to read the data of D*M bytes from the (N*M+1)-th byte in the QSD area. D is the data-size of the basic image data for each frame.

[**0057**] In the second storing scheme **20***d* of **FIG. 10**, the basic image data F0*f* and the total quality supplement data F1*f*+F2*f*+F3*f*+F4*f* may have arbitrary sizes. The start address of the total quality supplement data for an f-th frame in the QSD area is assumed to be Af. In order to know the quality supplement data address Af from the frame number f, the controller **10** uses an address table of **FIG. 11**. The address table of **FIG. 11** comprises a frame number (f) field and a field of QSD address (Af) for the frame number (f).

[**0058**] **FIG. 12** shows a third storing scheme **20***e* of storing a video object on the mass storage **20**. The mass storage **20** preferably comprises a suitable disc storage device such as a hard disc, various optical discs, etc. In this storing scheme **20***e*, the basic image data F0*f* and the quality supplement data QSDf (=F1*f*+F2*f*+ . . .) are stored in a same area with the latter just following the former in a manner like $F0_{f-1}$, QSD_{f-1}, $F0_f$, QSD_f, $F0_{f+1}$, QSD_{f+1} and so on. In this case, in normal play step **150** of **FIG. 6**, the controller **10** reads only the basic image data skipping the quality supplement data as shown by arrows above the strip area representative of the stored video data in **FIG. 12**. In the image quality enhancing operation in step **146**, the controller **10** reads the quality supplement data QSD_f for the frame identified by the register **501** value as shown by an arrow below the strip area representative of the stored video data in **FIG. 12**.

[**0059**] Progressive JPEG Format

[**0060**] The invention is applicable to video data of formats in which some of the frames are described by using differential data between frames: e.g., the progressive JPEG format, the H.263 format, MPEG-1 format and the MPEG-2 format. **FIG. 13** is a diagram showing a data structure obtained when a progressive JPEG video object is stored in the third storing scheme **20***e* as shown in **FIG. 12**. In **FIG. 13**, the basic image data F0*f* for each frame comprises a header F**0**Hf and a basic image data portion F**0**Df. The quality supplement data QSDf comprises a first level differential data F1*f*, a second level differential data F2*f*, . . . , and an L-th level differential data FL*f*.

[**0061**] In case of the progressive JPEG format, in normal play step **150** of **FIG. 6**, the controller **10** reads only the header F**0**Hf and the basic image data F**0**Df skipping the quality supplement data QSDf (=F1*f*, F2*f*, . . . , and FLf) for each frame f. In the image quality enhancing operation in step **146**, the controller **10** reads the quality supplement data QSDf for the frame identified by the register **501** value.

[**0062**] It is noted that the controller **50** passes the frame data to be displayed to the video & audio decoder **60** of **FIG. 1** in playing operations of steps **126**, **128**, **130** and **150**. In case of the progressive JPEG format, the video & audio decoder **60** includes a JPEG decoder.

[**0063**] H.263 Format

[**0064**] **FIG. 14** is a diagram conceptually showing the H.263 video format. In **FIG. 14**, an H.263 video data comprises basic image data **210** for use in a play operation and quality supplement data **220** for use in a quality enhancing operation. If the frame data for the basic image data are expressed as $F0_0$, $F0_1$, $F0_2$, . . . , F0*g*, . . . , and $F0_{3N+2}$ (g is a frame number), then the frame data can be expressed as $\{F0_{3f}, F0_{3f+1}, F0_{3f+2}: f=0, 1, \ldots, N\}$. In this case, the basic image frames identified by $F0_{3f}$ are intra-coded frames that can be decoded alone without the need of data of any other frame. On the other hand, the basic image frames identified by $F0_{f3+1}$ and $F0_{f3+2}$ are first and second differences, in the time direction, from the basic image data $F0_{3f}$ which needs

frame $F0_{3f}$ data for decoding. The first and second differences are written as TIME DIRECTION DIF **1** and **2**, respectively in **FIG. 14**. The quality supplement data for the frame **3***f* comprises first, second and third differences, in the quality direction, from the basic image data $F0_{3f}$, which differences are referred to as "QUALITY DIFs 1, 2 and 3" and labeled "$F1_{3f}$", "$F2_{3f}$" and "$F3_{3f}$", respectively. In a similarly manner, the quality supplement data for the frame **3***f*+1 comprises QUALITY DIFs **1**, **2** and **3** from the basic image data $F0_{3f+1}$ which differences are labeled "$F1_{3f+1}$", "$F2_{3f+1}$" and "$F3_{3f+1}$", respectively. Also, the quality supplement data for the frame **3**f+2 comprises QUALITY DIFs **1**, **2** and **3** from the basic image data $F0_{3f+2}$ which differences are labeled "$F1_{3f+2}$", "$F2_{3f+2}$" and "$F3_{3f+2}$", respectively.

[**0065**] **FIG. 15** is a schematic block diagram showing an exemplary arrangement of a video decoder **600** which is included in the video & audio decoder **60** of **FIG. 1** and which is adapted to decode a video object of the H.263 format as shown in **FIG. 14**. In **FIG. 15**, the video decoder **600** comprises a local controller **602** for controlling the operation of the decoder **600**; a time-based H.263 decoder **604**; an adder **606**; a frame memory **608** for storing a I-coded image data $F0_{3f}$: a memory interface **610** for the memory **608**; a quality-enhancing H.263 decoder **612** for decoding quality supplement data F1*g*, F2*g* and F3*g* to provide a quality-enhanced frame data F0*g*+F1*g*+F2*g*+F3*g*; and a previous frame memory for quality enhancement.

[**0066**] The received video data is passed to the video & audio decider **60** and to the video decoder **600** or the local controller **602** through the bus lines **51**. If the received video data is basic image data F0*g*, then the local controller **602** passes the data F0*g* to the time-based H.263 decider **604**. If the received video data is quality supplement data F1*g*, F2*g* or F3*g*, then the local controller **602** passes the data F1*g*, F2*g* or F3*g* to the quality-enhancing H.263 decider **612**.

[**0067**] The local controller **602** supplies a control signal **602***a* to a memory interface **610** control input **610***c*. The control signal **602***a* controls the memory interface **610** such that the data on the interface **610** data input terminal **610***a* is stored in the memory **608** if the received video data is I-coded image data, i.e., g=**3***f*. Thus, if the received video data is $F0_{3f}$, the decoded video data $[F0_{3f}]$ is stored in the frame memory **608**, where [A] represents a decoded version of data A.

[**0068**] The control signal **602***a* also controls the memory interface **610** such that the data stored in the frame memory **608**, i.e., the decoded video data $[F0_{3f}]$ is read out to a memory interface **610** data output terminal **610***b* if the received video data is not I-coded image data, i.e., g≠**3***f*. Thus, if the received video data is $F0_{3f+1}$ or $F0_{3f+2}$, the decoded video data $[F0_{3f+1}]$ or $[F0_{3f+2}]$ is added by the adder **606** to the decoded video data $[F0_{3f}]$ read from the memory **608** to yield the added decoded video data $[F0_{3f}]+[F0_{3f+1}]$ or $[F0_{3f}]+[F0_{3f+2}]$, respectively, which is supplied to the video output portion **80** and the previous frame memory **614**.

[**0069**] To the previous frame memory **614**, there are also supplied the decoded video data from the quality-enhancing H.263 decoder **612**. The H.263 decoder **612** decodes the quality supplement data F1*g*, F2*g* or F3*g* from the local controller **602**, and adds the decoded data [F1*g*], [F2*g*] or [F3*g*] to the data from the previous frame memory **614** to provide the quality enhanced frame data to the video output portion **80**.

[**0070**] It is noted that since the video decoder **600** has respective previous frame memories **608** and **614** and respective H.263 decoders **604** and **612** for a decoding in the time axis direction and a decoding in the quality axis direction, it is possible to store data decoded in the time axis direction in both of the previous frame memory **608** and **614** and to store data decoded in the quality axis direction only in the memory **614** for the quality axis direction. This reason, even if quality supplement data for a frame data F0*g* has been decoded, it is possible to resume the play of video data from the frame data F0*g*.

[**0071**] Though the above-described video decoder **600** has used two H.263 decoders, an equivalent video decoder may be implemented by using a single decoder.

[**0072**] A video decoder that decodes a video object of a format using a correlation between frames not only in the time axis direction but also in the quality axis direction has been described in conjunction with the H.263 video format. However, such a video decoder can be realized for other such video format as MPEG format by replacing the H.263 decoder(s) with a corresponding video decoder such as an MPEG decoder.

[**0073**] Though the above-described embodiments has dealt with a single media program, i.e., a video object, the following embodiment deals with a multimedia program.

Embodiment II

[**0074**] A multimedia-on-demand system according to a second illustrative embodiment of the invention has a feature of enhancing the picture quality of the first frame to be displayed after the execution of a stop command or the execution of a JF, JB or HS command issued during a stop state by transmitting quality supplement data from the server **1**.

[**0075**] **FIG. 16** is a diagram showing an exemplary scenario data table of a multimedia program available in a multimedia-on-demand system according to a second illustrative embodiment of the invention. In **FIG. 16**, the scenario data table contains a record for each of the multimedia objects used in the multimedia program for which the scenario data table is intended. Each record of the scenario data table comprises the fields of the object ID, the kind of the object, the display position on a screen, the display size, the presentation start time and the presentation end time. For the sake of better understanding, in the presentation start and end time fields, there is included corresponding value of the scenario time counter **501**, Ct. In this specific example, the frame rate of the video objects is assumed to be 30 frames per second.

[**0076**] In order to simplify the operation, it is preferable to create an active object table as shown in **FIG. 17** from the scenario data table. In **FIG. 17**, all of the Ct values found in the presentation start and end time fields of the scenario data table are listed in the ascending order in the first column or fields of the event list table. For each of the listed Ct values, there are listed, in the second field, the object IDs of multimedia objects the presentation of which is started or ongoing at the Ct value. However, each second field does not include the object the presentation of which ends at the Ct values.

[**0077**] **FIG. 18** is a flowchart showing an operation executed by the controller **50** of the client terminal **3** under

the control of an interrupt subroutine called from a main program in response to an interrupt caused by the user at the client terminal **3** pressing one of the presentation control buttons of **FIG. 3** after specifying one of the available multimedia programs stored in the mass storage **20**. Since the operation **220** of **FIG. 18** is very similarly to that of **FIG. 6**, only the difference between them will be described in the following.

[**0078**] If JB, JF or HS command is detected in step **124**, then instead of executing a JB play step **126**, a JF play step **128** or a HS play step **130**, the controller **50** sets the register **501** value Ct to Ct−Cj, Ct+Cj or 0 in a JB step **240**, a JF step **242** or a HS step **244**, respectively; and returns to the main program to resumes the normal play operation of the current program from the register **501**.

[**0079**] In step **250** of the normal play operation comprising steps **250**, **152** and **154**, the controller **50** presents relevant object(s) referring to the active object table of **FIG. 17**. Specifically, if the current value Ct is found in any Ct field of the table, the controller **50** continues the presentation of the object(s) which is (or are) listed in both the current record whose Ct field contains the current Ct value and the just above records in the table; ceases the presentation of the object(s) which is (or are) found in the just above record but not found in the current record, and starts the presentation of the object(s) which first appears (or appear) in the current record. If the current value Ct is not found in any Ct field of the active object table, the controller **50** has only to repeat the same operation as executed for the last Ct value.

[**0080**] in a manner well known in the art. In this case, if a video frame is to be displayed, the controller **50** only uses basic data for the frame.

[**0081**] After step **137**, **140**, **142** or **144**, the controller **50** makes a test in step **238** to see if a video object exists in the record whose Ct value filed contains a largest value not exceeding the value of the scenario time register **501**, Ct. If so, the controller **50** performs the image enhancing operation for the frame identified by the current register **501** value Ct minus the register **501** value of the presentation start time SCt of the video object in step **139**. This is because the current register value Ct equals the sum of the presentation start time Ct value SCt and the frame number of the video object.

[**0082**] After step **139**, the controller **50** ends the operation **220**. If the test result is NO in step **238**, then the controller **50** ends the operation **220**.

[**0083**] As described above, the image enhancing operation of step **139** enhances the picture quality of the frame to be displayed after the execution of a stop command or the execution of a JF, JB or HS command issued during a stop state.

[**0084**] It should be noted that the image enhancing operation may be performed for a plurality of frames beginning the frame identified by the value of Ct−SCt.

Embodiment III

[**0085**] According to a third illustrative embodiment of the invention, a multimedia-on-demand system adds detailed information to (or enhances the quality of) each of variable-quality objects during a stop period in a manner as illustrated by a part labeled "QUALITY ENHANCING OPERATION" in **FIG. 21**. A variable-quality object is a multimedia object that comprises a plurality of detail levels of data and that permits an enhancement of the presentation quality by adding a higher detail level of data. The above-mentioned progressive JPEG video is one of such variable-quality objects. **FIG. 19** is a diagram showing examples of variable-quality objects. In **FIG. 19**, still pictures A, B, C and D are variable in the display quality according to the difference data levels used for presentation. Also, the text object of **FIG. 19** is said to be a variable—quality object since the text object comprises a plurality of detail levels of data.

[**0086**] Also, the client terminal of the multimedia-on-demand system tries to collect as much object data as possible in advance during a stop period so that a random access operation such as a JF operation can be promptly executed. This collection operation is shown by a part labeled "PRELOAD OPERATION" again in **FIG. 21**.

[**0087**] **FIG. 22** is a flowchart showing an operation of an interrupt subroutine **230** called in response to a pressing of one of the presentation control buttons of **FIG. 3** according to the third embodiment of the invention. The interrupt subroutine **230** is identical to that of **FIG. 18** except that after step **137**, the controller **50** executes steps **260** and **270** instead of proceeding to step **238**.

[**0088**] In step **260**, the controller **50** performs an image quality enhancing operation for at least one frame beginning the frame identified by the value of Ct−SCt for each of the active variable-quality objects. For this purpose, it is preferable to add an field **265** for containing a variable-quality flag indicative of whether the objet is variable in presentation quality or a loading priority code indicative of the priority order of the object in a load operation as shown in **FIG. 23**. If there are a plurality of active objects with an identical priority code, the controller **50** preferably processes the objects in order of presentation.

[**0089**] Also, it is preferable to keep a load flag for each object as shown in **FIG. 24**. The load flag for an object indicates whether the basic data of the object has been loaded or not. The load flags are all reset in an initial operation.

[**0090**] In step **270**, the controller **50** preferably tries to load basic data of as many object to be subsequently presented as possible in advance. In order to distinguish the loaded object from not-loaded ones, the controller **50** sets the load flag each time the load operation of the basic data of an object has been completed. This enables a quick response in a random access operation such as a fast ford operation.

[**0091**] Many widely different embodiments of the present invention may be constructed without departing from the spirit and scope of the present invention. It should be understood that the present invention is not limited to the specific embodiments described in the specification, except as defined in the appended claims.

1. A method of presenting, at a client terminal, a video program stored in a server linked with the client terminal, the method comprising the steps of:

preparing a plurality of levels of quality supplement data in the server as each of a plurality of quality supplement data portions;

storing a plurality of basic data portions on a recording medium in the server;

storing each level of the quality supplement data on a recording medium in the server;

preparing one basic data portion and one quality supplement data portion for each frame of the video program in the server, a quality of the video program at each frame played based on a combination of the basic data portion and the quality supplement data portion being higher than that based on only the basic data portion;

in response to a play command in the client terminal, obtaining the basic data portions of the frames of the video program needed to play the video program by using the basic data portions of the frames; and

in response to a stop command in the client terminal, adding the quality supplement data portion of the last displayed frame to display a quality-enhanced version of the last displayed frame by using a combination of the basic data portion and the quality supplement data portion

2. A method as defined in claim 1, further comprising the step of, in response to one of a head search command, a jump forward command and a jump backward commands in the client terminal, adding the quality supplement data portion, of the last displayed frame to display the quality-enhanced version of said last displayed frame by using the combination of the basic data portion and the quality supplement data portion.

3. (canceled)

4. A method as defined claim 1, further comprising the steps, executed by said server, of:

moving the recording media synchronously in any of a play operation, a head search operation, a jump forward operation or a jump backward operation; and

in response to a quality supplement data request from said client terminal, sending at least one level of quality supplement data of the last displayed frame to the client terminal by reading the level of the quality supplement data while synchronously moving the recording media, wherein the quality supplemental data request are prepared in response to the stop command.

5-9. (canceled)

10. A method as defined in claim 1, wherein each frame of the video program has been coded according to a coding standard, wherein the program comprises independent frames that can be decoded alone without the a need of other frame data and different frames that can not be decoded without other frame data, and wherein the step of obtaining the basic data portions said using includes passing to a decoder, and the step of adding the quality supplement data portion includes passing the quality supplement data portion to the decoder.

11. A method as defined in claim 10, wherein said coding standard is an H.263 standard, the step of obtaining the basic data portions includes passing the basic data portions to an H.263 decoder, and the step of adding the quality supplement data portion includes passing the quality supplement data portion to the H.263 decoder.

12. A method as defined in claim 10, wherein the coding standard is an MPEG standard, the step of obtaining the basic data portions includes passing the basic data portions to an MPEG decoder, and the step of adding the quality supplement data portion includes passing the quality supplement data portion to the MPEG decoder.

13-33. (canceled)

34. A method as defined in claim 1, wherein the step of adding said supplement data portion comprises:

providing a plurality of levels of quality supplement data; and

applying each level of quality supplement data in sequence to gradually increase the quality of the video program at the last displayed frame played by a combination of the basic data portion and the level of quality supplement data.

35. A method as defined in claim 1 wherein said recording medium is a tape recording medium.

36. A method as claimed in claim 1 wherein said recording medium comprises a plurality of recording media.

37. A method as claimed in claim 35 wherein said recording media comprise a plurality pf tape recording media.

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