

(21) Application No: **0606100.6**
 (22) Date of Filing: **21.02.2005**
 Date Lodged: **27.03.2006**
 (30) Priority Data:
 (31) **2004321451** (32) **05.11.2004** (33) **JP**
 (62) Divided from Application No **0503611.6** under Section 15(4) of the Patents Act 1977

(51) INT CL:
H04N 7/01 (2006.01)
 (52) UK CL (Edition X):
H4F FER
 (56) Documents Cited:
US 6055018 A
 (58) Field of Search:
 UK CL (Edition X) **H4F**
 INT CL **H04N**
 Other: **WPI, EPODOC, TXTUS0, TXTUS1, TXTUS2, TXTUS3, TXTEP1, TXTGB1, TXTWO1, TXTAU1, INSPEC**

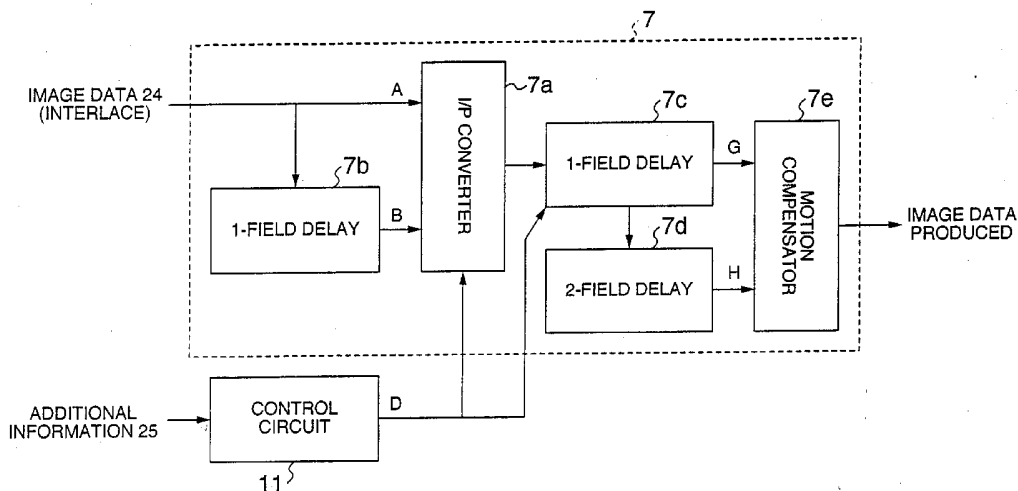
(71) Applicant(s):
Hitachi Ltd
(Incorporated in Japan)
6-6 Marunouchi 1-chome, Chiyoda-ku,
Tokyo, Japan

(continued on next page)

(54) Abstract Title: **Interlace to progressive scan conversion using image signal pull down phase information**

(57) A digital signal broadcast receiver (1, Figure 1) comprises a tuner and decoder (22, 23: Figure 1) for receiving and decoding a compressed, encoded digital image signal, an interlace to progressive (I/P) scan converter 7, and a control unit 11. In response to pull-down phase information obtained at the time of image signal decoding, control unit 11 controls the I-P standards converter to make progressive scan type conversion, for example as shown schematically in Figure 9. Alternatively, motion vector information is also used to carry out compensation in motion compensator 7e, producing smoother display of movement. As described, interlace to progressive scan conversion is performed on image data from a movie source previously processed in a 2-3 (or 2:3) pull down manner.

FIG. 12



GB 2422977 A continuation

(72) Inventor(s):

**Mitsuo Nakajima
Yoshiaki Mizuhashi
Haruki Takata**

(74) Agent and/or Address for Service:

**Mewburn Ellis LLP
York House, 23 Kingsway, LONDON,
WC2B 6HP, United Kingdom**

FIG. 1

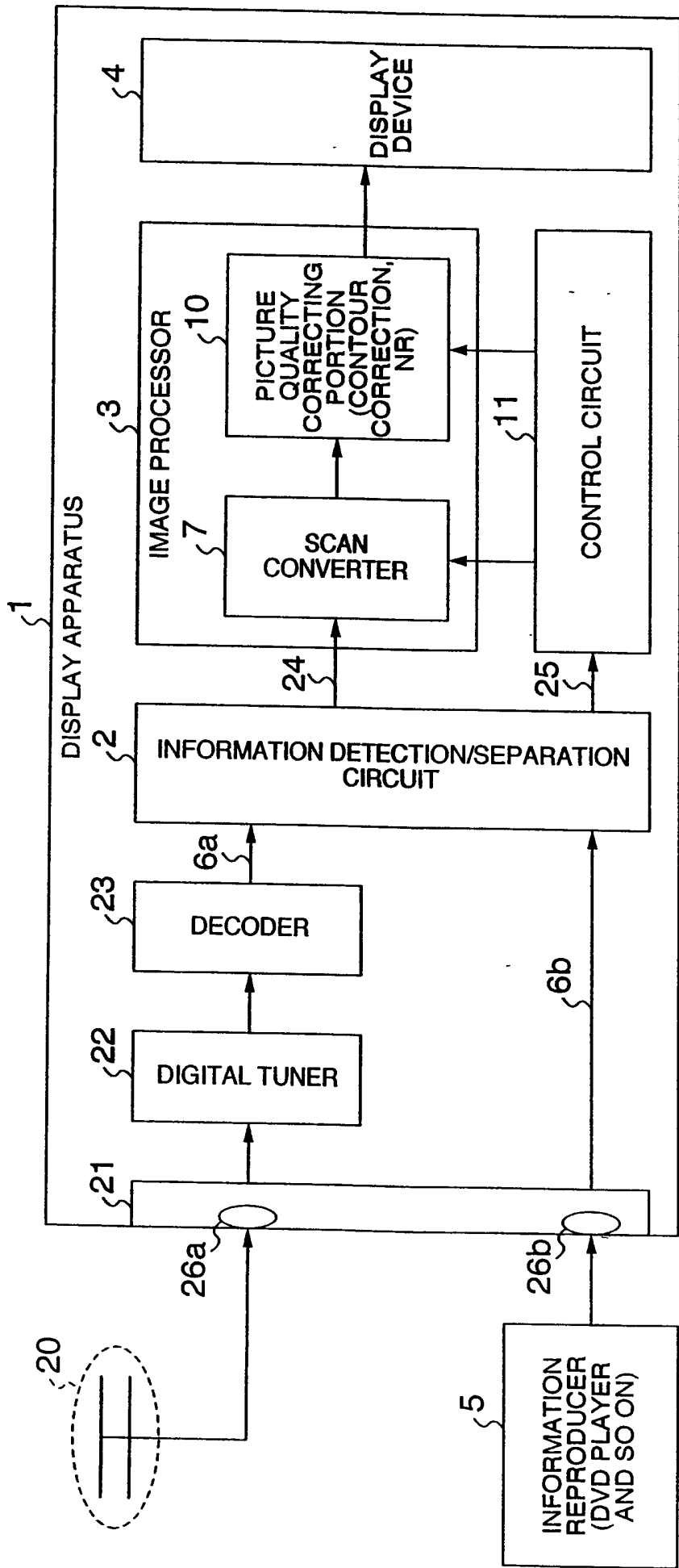


FIG. 2

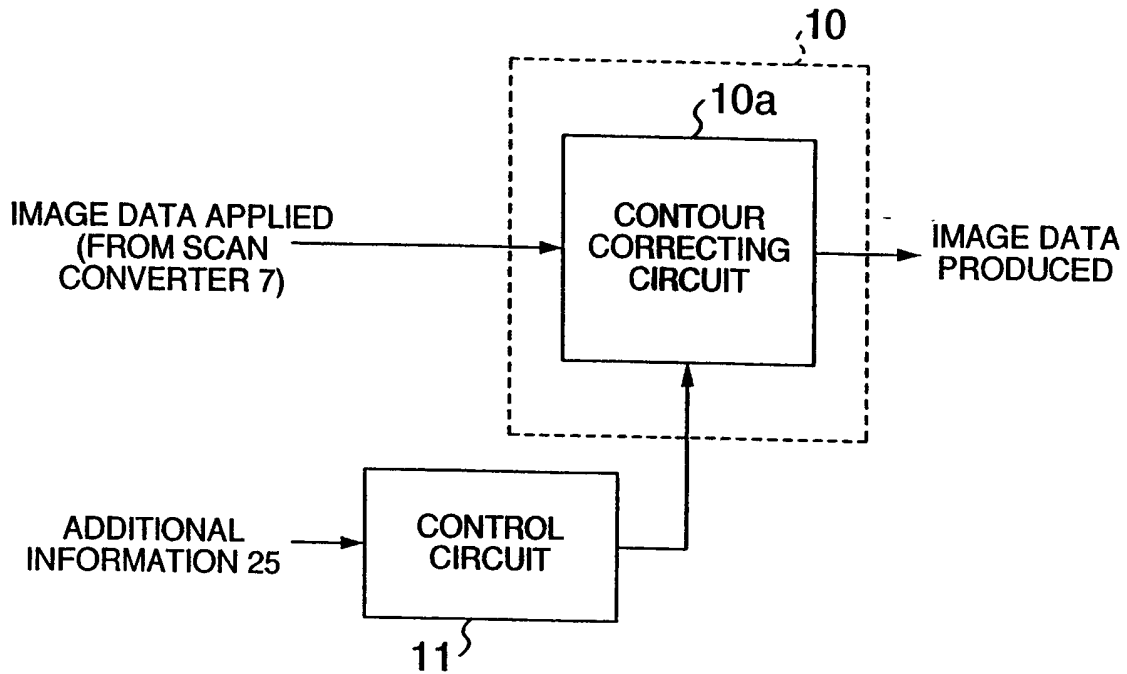


FIG. 3

FRAME TYPE	AMOUNT OF CONTOUR CORRECTION
I PICTURE	SMALL
B PICTURE	LARGE
P PICTURE	LARGE

FIG. 4

FRAME TYPE	AMOUNT OF CONTOUR CORRECTION		
	LOW BIT RATE	MIDIUM BIT RATE	HIGH BIT RATE
I PICTURE	1 (SMALL)	3	4
B PICTURE	2	4	5
P PICTURE	2	4	5 (LARGE)

FIG. 5

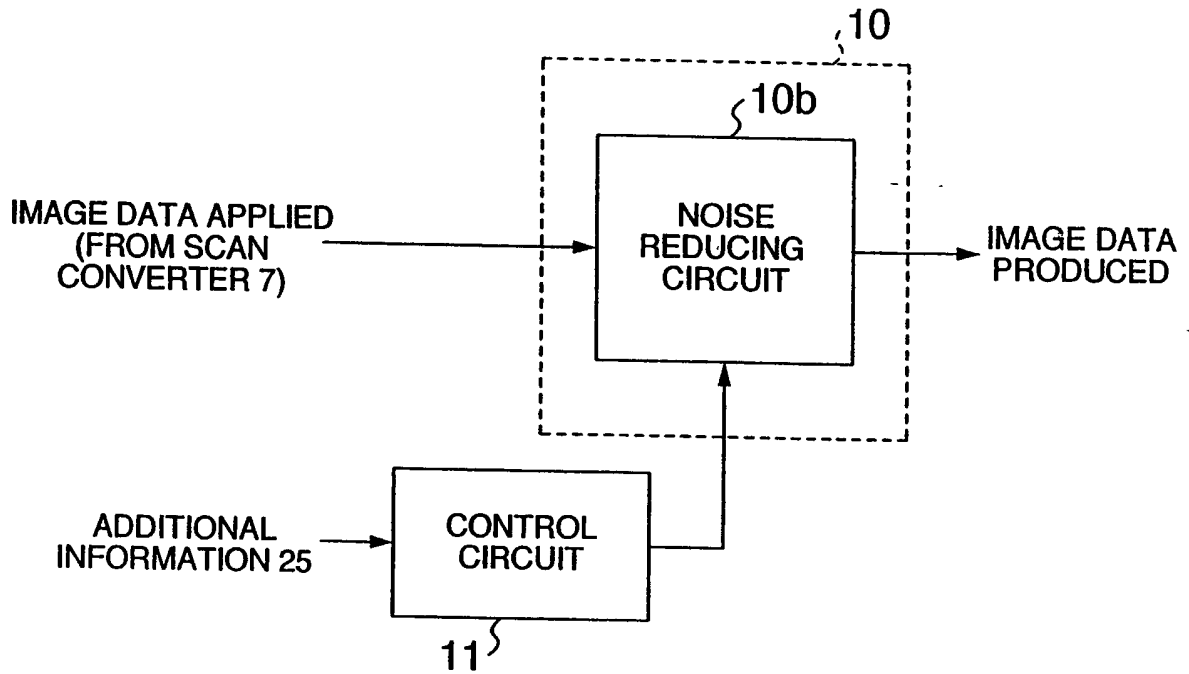


FIG. 6

FRAME TYPE	AMOUNT OF NOISE REDUCTION		
	LOW BIT RATE	MIDIUM BIT RATE	HIGH BIT RATE
I PICTURE	5 (LARGE)	3	2
B PICTURE	4	2	1
P PICTURE	4	2	1 (SMALL)

FIG. 7

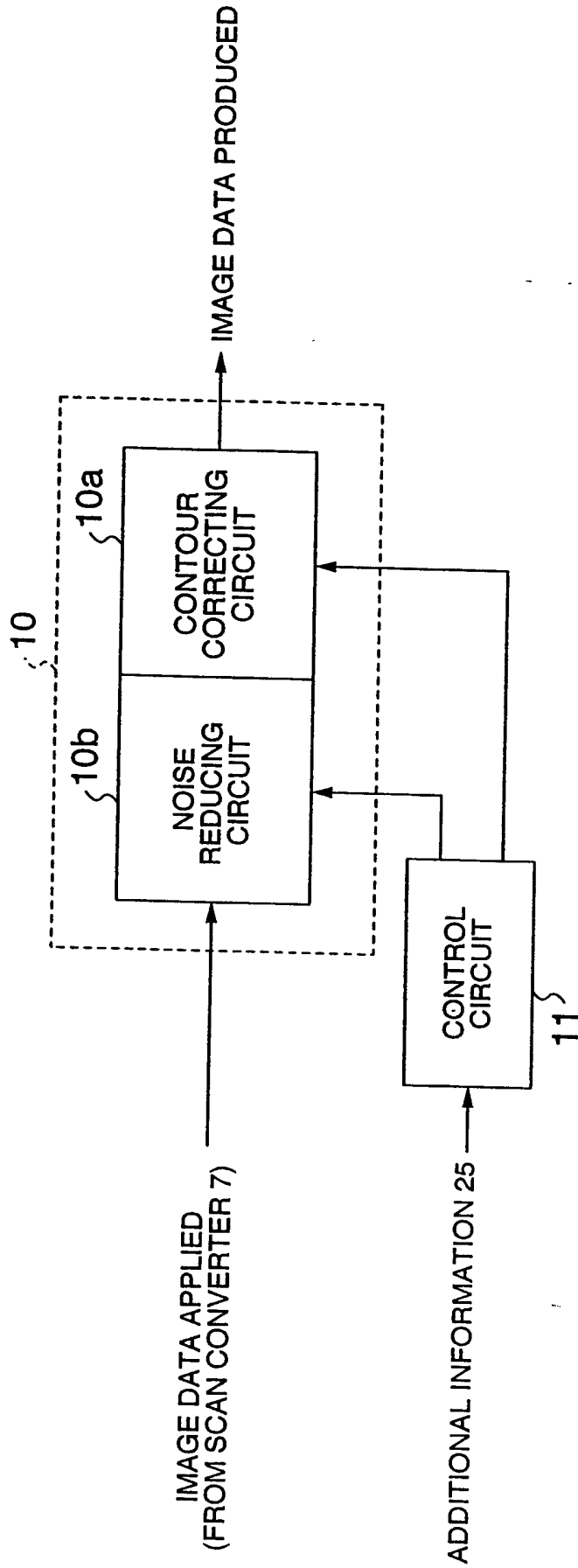


FIG. 8

FRAME TYPE	AMOUNT OF NOISE REDUCTION		
	LOW BIT RATE	MIDIUM BIT RATE	HIGH BIT RATE
I PICTURE	5 (LARGE)	3	2
B PICTURE	4	2	1
P PICTURE	4	2	1 (SMALL)

FRAME TYPE	AMOUNT OF CONTOUR CORRECTION		
	LOW BIT RATE	MIDIUM BIT RATE	HIGH BIT RATE
I PICTURE	1 (SMALL)	3	4
B PICTURE	2	4	5
P PICTURE	2	4	5 (LARGE)

FIG. 9

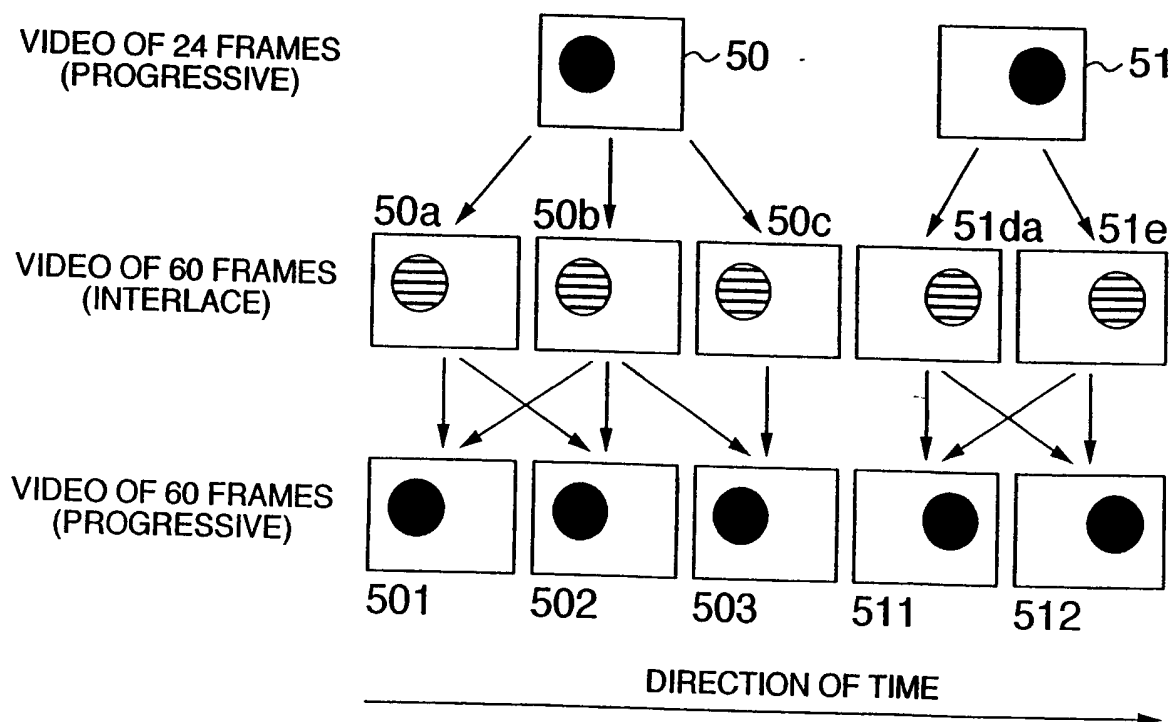


FIG. 10

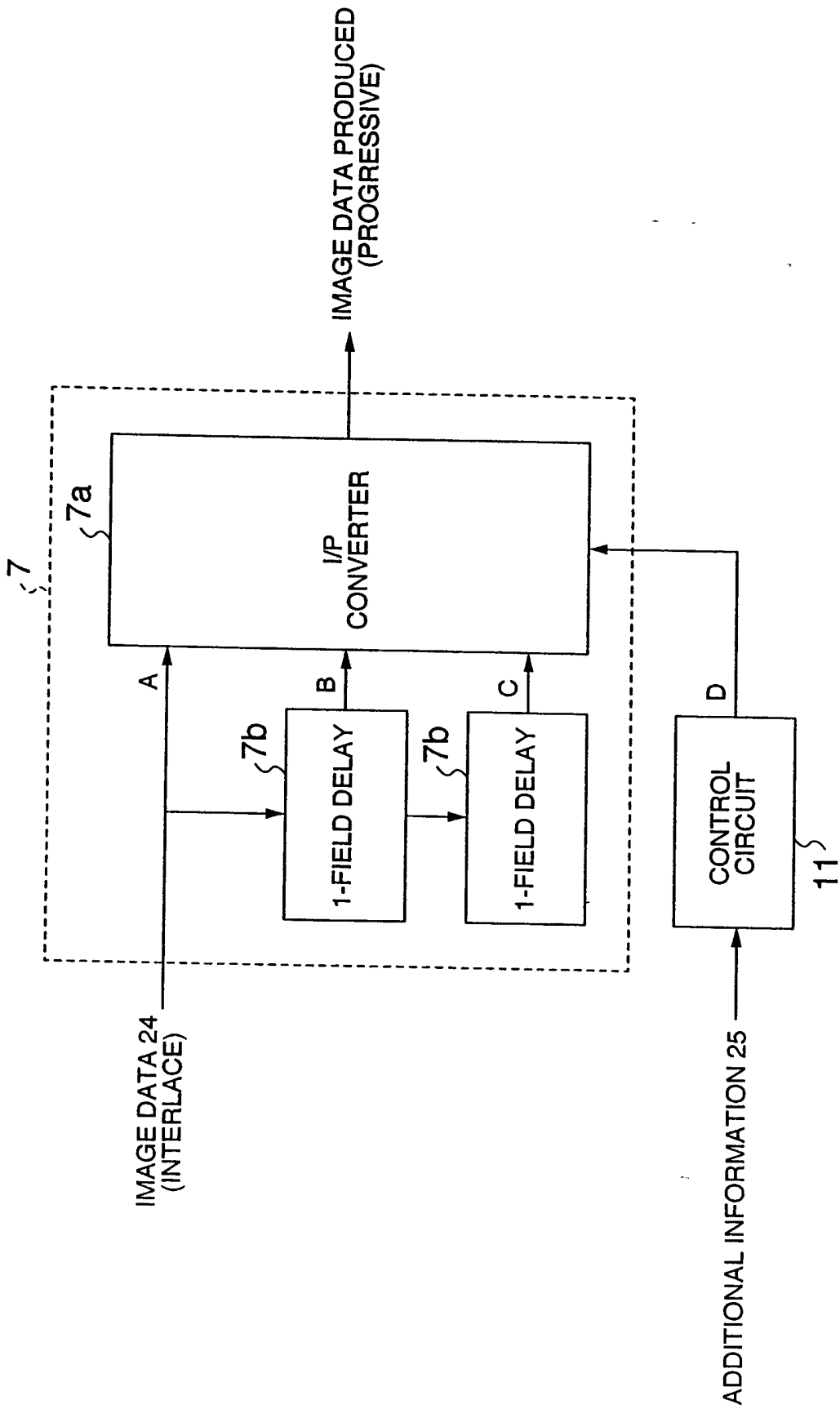


FIG. 11

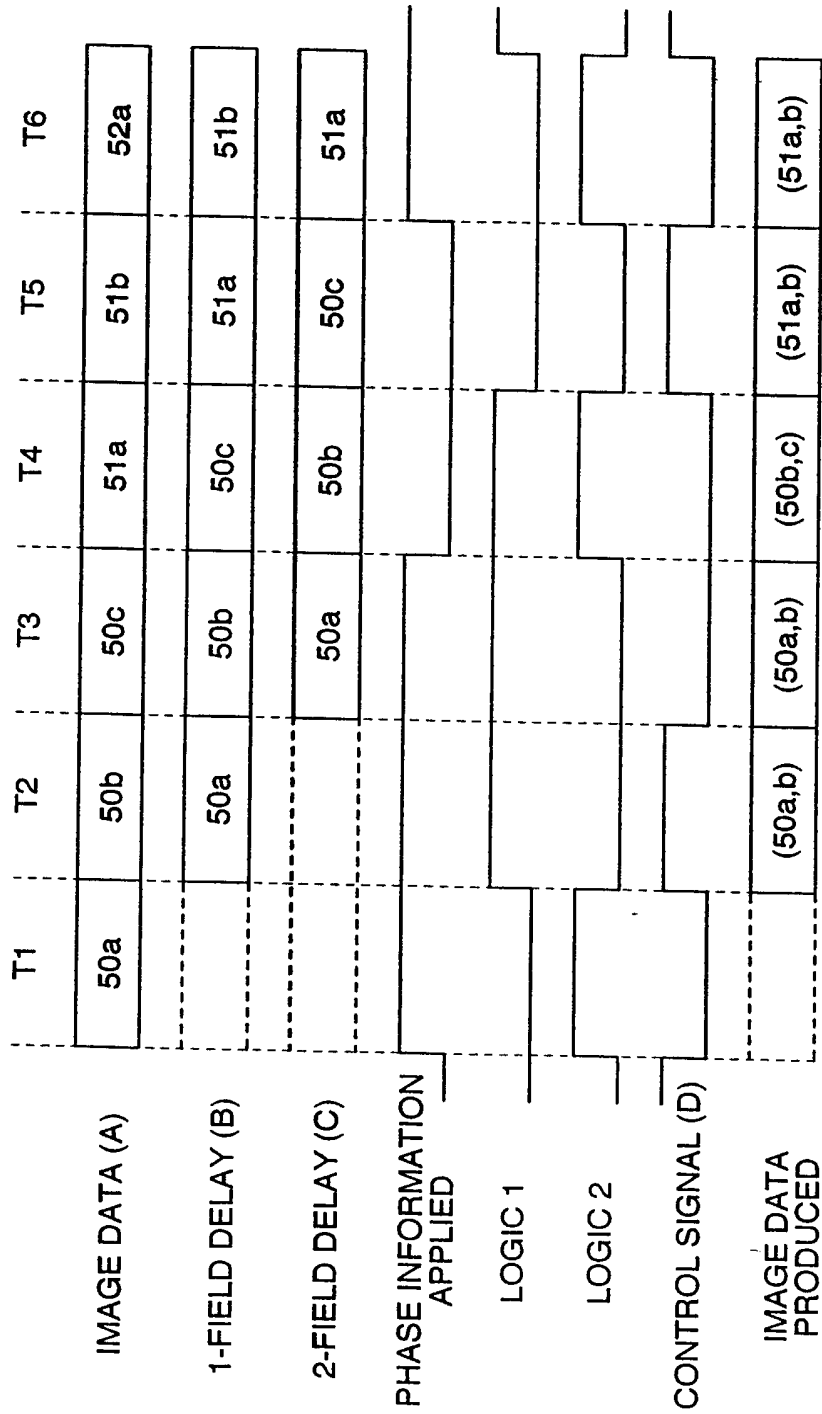
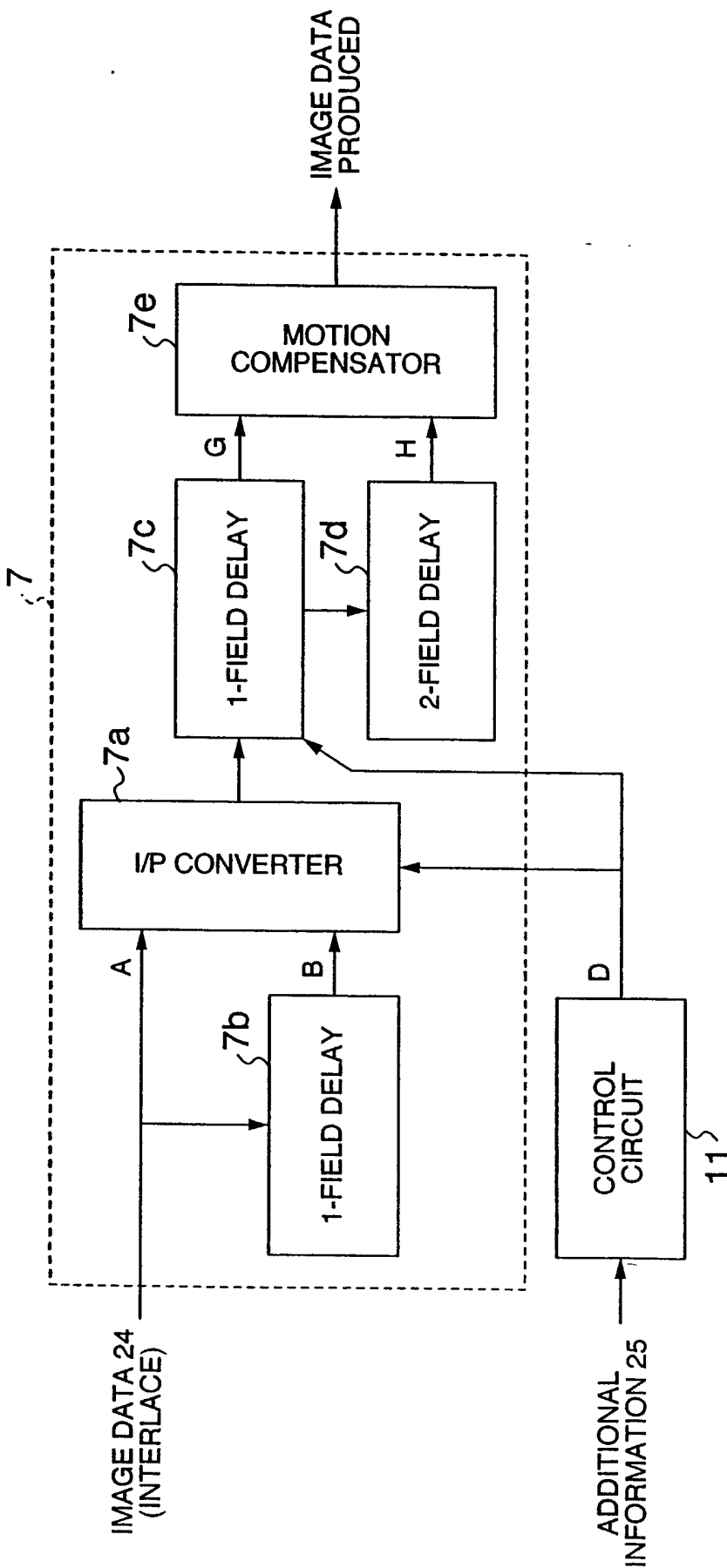


FIG. 12



ADDITIONAL INFORMATION 25

IMAGE DATA 24 (INTERLACE)

MOTION COMPENSATOR

I/P CONVERTER

1-FIELD DELAY

2-FIELD DELAY

CONTROL CIRCUIT

IMAGE DATA PRODUCED

FIG. 13

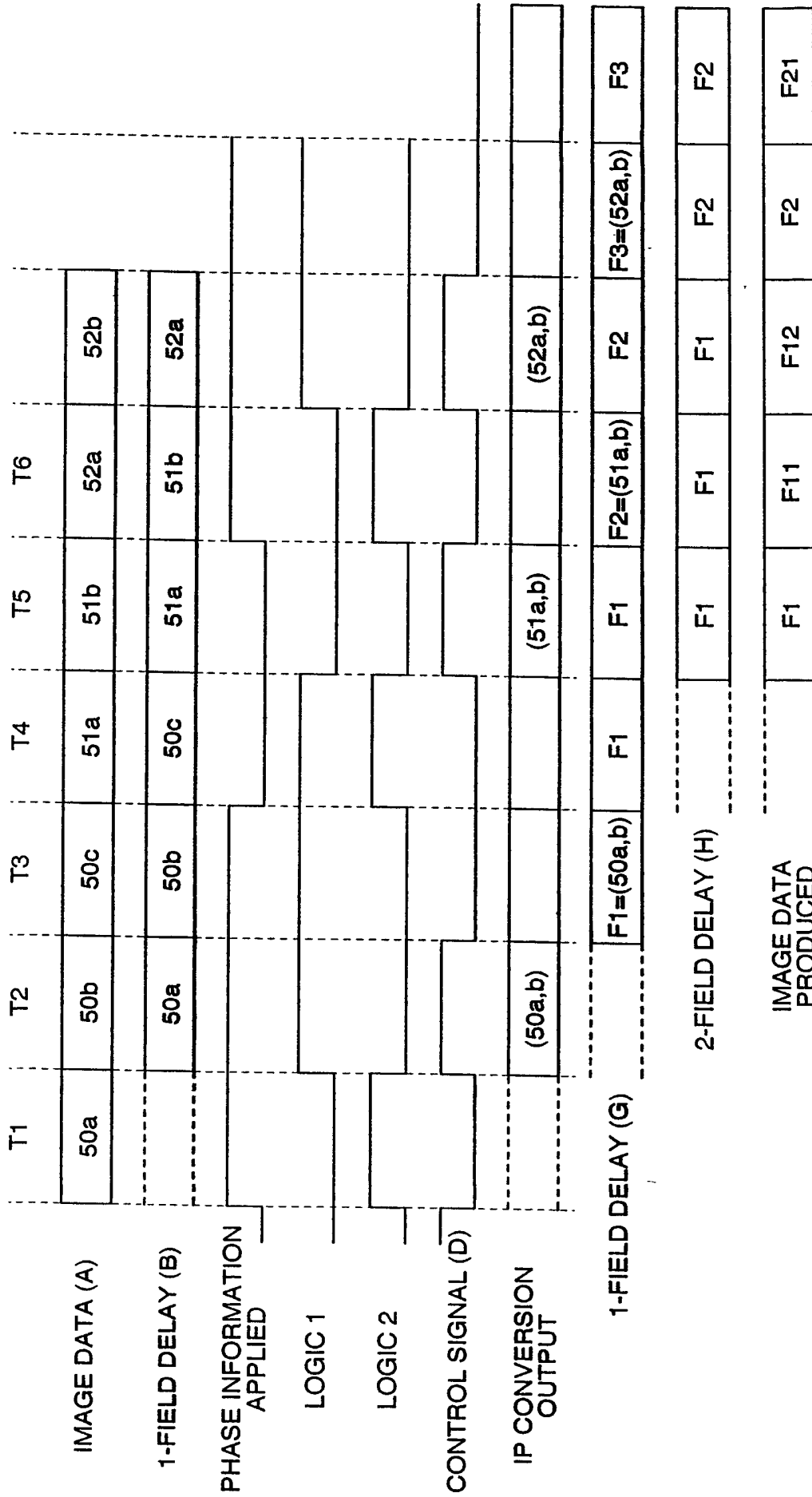
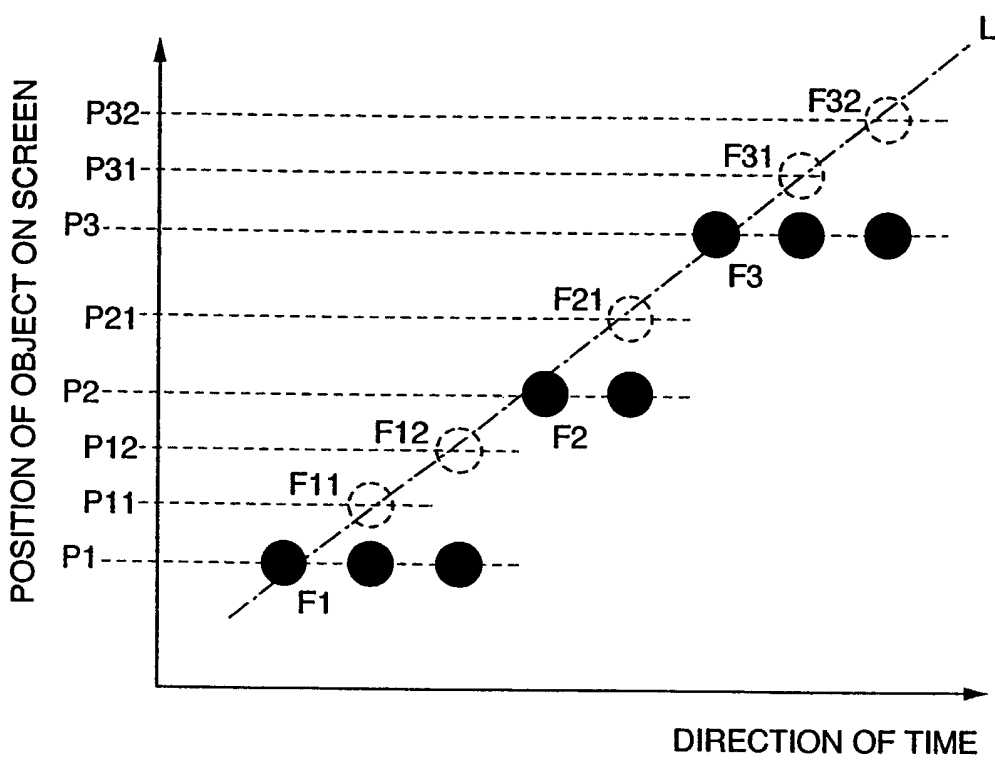


FIG. 14



2422977

- 1 -

IMAGE DISPLAY APPARATUS

The present invention relates to image display apparatus and digital television broadcast receiving apparatus, and particularly to an image display apparatus and digital television broadcast receiving apparatus in which the picture quality is corrected for by using additional information added to the inputted image signal.

10 Description of the Related Art

A digital image signal compressed to encode in an MPEG form has additional information added such as frame encoding information for each frame (information for I-picture, P-picture or B-picture), bit rate information and motion vector information.

A technique for reducing block noise and mosquito noise by using the frame encoding information of the above additional information is described in, for example, JP-A-10-56646 or JP-A-9-149417.

20

The prior arts described in JP-A-10-56646 and JP-A-9-149417 make only the process for reducing noise such as block noise and mosquito noise by using the additional information, and do not consider contour

correction. In addition, the above prior arts use only the frame encoding information as the additional information to make picture quality correction such as noise reduction, and thus under this condition it is
5 difficult to grasp correct state of pictures.

This invention provides a technique for making it possible to display higher-quality pictures when a digital image signal is applied and displayed.

Moreover, this invention is characterized by
10 the detection of the additional information applied together with the digital image signal, and by the contour correction for the image signal by using the detected additional information. This additional information is, for example, the information about
15 frame encoding added to each frame of the image signal (namely, information indicative of I-picture, P-picture and B-picture).

This invention is also characterized by the use of not only the frame encoding information but also
20 bit rate information as the additional information used for the picture quality correction processes such as contour correction and noise reduction processes. In other words, this invention has another feature that, at least one of the contour correction and noise
25 reduction is performed by using a combination of the detected frame encoding information and bit rate information.

Furthermore, this invention has still another

feature that the frame encoding information and bit
rate information produced when the stream of a received
digital broadcast signal is decoded are used to perform
the picture quality correction such as contour
5 correction and noise reduction. According to this
invention, high quality images can be displayed.

Other objects, features and advantages of the
invention will become apparent from the following
description of the embodiments of the invention taken
10 in conjunction with the accompanying drawings.

In the drawings

FIG. 1 is a block diagram showing the first
embodiment of an image display apparatus according to
this invention.

15 FIG. 2 is a block diagram showing an example
of a picture quality correction circuit 10 in the first
embodiment.

FIG. 3 is a diagram showing a table structure
for determining the amount of contour correction.

20 FIG. 4 is a diagram showing another table
structure for determining the amount of contour
correction.

FIG. 5 is a block diagram showing the second
embodiment according to the invention.

25 FIG. 6 is a diagram showing a table structure
for determining the amount of noise reduction.

FIG. 7 is a diagram showing the third

embodiment according to the invention.

FIG. 8 is a diagram showing an example of a table structure for determining the amount of noise reduction and the amount of contour correction.

5 FIG. 9 is a diagram showing an example of image data processed according to a 2-3 pull-down system.

FIG. 10 is a diagram showing the fourth embodiment according to the invention.

10 FIG. 11 is a diagram showing the operation of the fourth embodiment.

FIG. 12 is a diagram showing the fifth embodiment according to the invention.

15 FIG. 13 is a diagram showing the operation of the fifth embodiment.

FIG. 14 is another diagram showing the operation of the fifth embodiment.

Preferred embodiments of the invention will
20 be described with reference to the accompanying drawings.

[Embodiment 1]

FIG. 1 is a block diagram of an embodiment of a display apparatus 1 according to the invention. The
25 display apparatus 1 shown in FIG. 1 corresponds to an example of a receiver capable of receiving a digital television broadcast and displaying it. A selected

digital television broadcast signal of a desired channel (such as a ground-based digital broadcast signal or BS/CS digital broadcast signal, hereinafter abbreviated DTV signal) is supplied through an antenna
5 20 and a first input terminal 26a provided within an input interface 21 to a digital tuner 22. Here, the DTV signal received by the digital tuner 22 is an MPEG stream including a digital image signal of, for example, MPEG type formed by compression encoding.
10 This stream includes various types of additional information such as information about encoding a corresponding frame, or encoding information added for each frame of the image signal (hereinafter, called the frame encoding information), information of data rate
15 of the stream (transfer rate), information of motion vector between frames, information of intra-frame macro block, and information of pull-down phase. The pull-down phase information will be later described in detail. The above frame encoding information includes
20 I-pictures indicating that the corresponding frame is encoded within the current frame, or intra-frame encoded, P-pictures indicating that the frame is encoded by using the previous frame, and B-pictures indicating that the frame is encoded by using the
25 previous and next frames.

The DTV signal received by the digital tuner 22 is demodulated by the digital tuner 22, and then expanded and decoded by a decoder 23. The decoded DTV

signal is supplied to an information detection/separation circuit 2 as decoded data 6a containing digital image data and the above additional information.

5 The digital broadcast receiving/displaying apparatus of this embodiment is able to receive not only the DTV signal but also the digital image signal reproduced from certain recording media. An information reproducer 5 such as a DVD player
10 reproduces and decodes an image signal from a DVD on which a digital image signal compressed to encode in an MPEG form is previously recorded. The decoded data from the information reproducer 5 includes the image data and the above additional information as does the
15 DTV signal. The decoded data is supplied through an input terminal 26b of the input interface 21 to the information detection/separation circuit 2. The standard for the transmission of both this digital image data and the other information is, for example,
20 HDMI specification. However, here the transmission standard is not particularly limited to this specification, but may be arbitrary as long as the digital image and the other information can be transmitted together.

25 The information detection/separation circuit 2 detects and extracts the above additional information from either one or both of the decoded data 6a and 6b so that the decoded data can be separated into image

data 24 and additional information 25. In other words, the information detection/separation circuit 2 separates image data 24 and additional information 25 from the decoded data 6a and/or 6b and produces them at its output end. Although not shown, a switch circuit may be provided on the input side of the information detection/separation circuit 2. This switch circuit selects any one of these decoded data 6a and 6b in accordance with, for example, a command from the user, and then supplies it to the information detection/separation circuit 2.

The image data 24 fed from the information detection/separation circuit 2 is supplied to an image processor 3. The image processor 3 includes a scan converter 7 for converting the inputted image data 24 to a signal of the progressive scan type when it is of the interlace scan type (namely when the DTV signal or the decoded data 6b from the information reproducer is of the interlace scan type), and a picture quality correction circuit 10 for making certain picture quality correction for the output signal from the scan converter 7. The picture quality correction circuit 10 makes contour correction processing to correct for the contour of the image data, and noise reduction processing (NR) to reduce the noise of the image data. Although not shown, other processes such as contrast correction, color correction and gamma correction are performed. On the other hand, the additional

information 25 produced from the information
detection/separation circuit 2 is supplied to a control
circuit 11. The control circuit 11, which is formed
of, for example, a microcomputer, analyzes the
5 additional information 25 fed, and supplies an
appropriate control signal according to the type of
this information to the image processor 3. If the
additional information is, for example, motion vector
information, macro block information or pull-down phase
10 information, the control circuit 11 generates a first
control signal for controlling the progressive scan
processing and supplies it to the scan converter 7 of
the image processor 3. If the additional information
is frame encoding information or data rate information,
15 the control circuit 11 generates a second control
signal for controlling the amount of picture quality
correction, and supplies it to the picture quality
correction circuit 10 of the image processor 3.

The image data 24 fed to the image processor
20 3, when the image data is of the interlace scan form,
is converted by the scan converter 7 to a progressive
scan form on the basis of the first control signal from
the control circuit 11. The output signal from the
scan converter 7 is corrected for its contour and
25 reduced in its noise by the picture quality correction
circuit 10 under the control of the second control
signal from the control circuit 11. The signal
corrected for its picture quality in the picture

quality correction circuit 10 is supplied to a display device 4. The display device 4 displays the image based on this signal. The display device 4 is, for example, a flat panel device such as a plasma display panel, liquid crystal panel or field emission display panel. It may be a micro mirror device or liquid crystal panel for projection type display.

The construction of the picture quality correction circuit 10 of the image processor 3, which is a characteristic portion of this embodiment, will be described with reference to FIGS. 2 through 4. The picture quality correction circuit 10 shown in FIG. 2 includes a contour correction circuit 10a for making contour correction for the image data produced from the scan converter 7. This contour correction circuit 10a extracts the contour components of the image by, for example, finding the second derivative of the image data or the difference between the adjacent pixels. The extracted contour components are amplified and added to the original image data, thereby correcting (emphasizing) the contour. Thus, the contour of the image looks clear, and thus the image becomes highly attractive. This processing or the construction for this processing is called the enhancer. In this embodiment, the control circuit 11 controls the degree that the above contour components are amplified (the amount of contour correction). In this embodiment, the additional information 25 separated by the information

detection/separation circuit is supplied to the control circuit 11. This additional information is the frame encoding information that indicates which one of I-picture, B-picture and P-picture of MPEG corresponds to each field of the image data 24.

In this case, the I-picture has a characteristic to easily cause block noise and mosquito noise, and B-picture and P-picture have characteristics not to easily cause block noise and mosquito noise as compared with the I-picture. Therefore, if the amount of contour correction is increased for the I-picture, noise is apt to be highly visible. The control circuit 11 according to this embodiment has stored therein a table of the association between the frame encoding information type and the amount of contour correction as shown in FIG. 3, and controls the amount of contour correction according to this table. If information of I-picture is supplied to the control circuit 11 as the frame encoding information, the control circuit 11 selects the "SMALL" amount of contour correction by referring to the table of FIG. 3. Then, the control circuit 11 supplies the control signal of this amount of contour correction to the contour correction circuit 10a, thus controlling it to correct the contour by this amount. Therefore, when the I-picture frame is displayed, the block noise and mosquito noise can be made not to be conspicuous on the display device. In addition, when information of B-picture or P-picture is

supplied as frame encoding information to the control circuit 11, the "LARGE" amount of contour correction is selected by referring to the table of FIG. 3. The control signal of this amount of contour correction is
5 supplied to the contour correction circuit 10a, thus controlling the amount of contour correction in the contour correction circuit 10a. Since the B-picture or P-picture has relatively small block noise and mosquito noise, the noise is not noticeable even if the amount
10 of contour correction is increased to emphasize the contour. While the amounts of contour correction are selected the same for the B-picture and P-picture in this embodiment, they may be different. When the amount of noise in P-picture is more than that in B-
15 picture, the amount of contour correction for P-picture may be decreased as compared with that for B-picture.

In addition, the amount of contour correction may be controlled in consideration of not only the frame encoding information but also the bit rate
20 information. An example of using a combination of the frame encoding information and the bit rate information to control the amount of contour correction will be described with reference to FIG. 4. The circuit arrangement of this example is assumed to be the same
25 as shown in FIG. 2. FIG. 4 shows a table different from that of FIG. 3, or specifying the association among the types of frame encoding information, the bit rate information and the amounts of contour correction.

This table is held in the control circuit 11 as is the table of FIG. 3.

In this case, the noise is increased with the decrease of bit rate, and decreased with the increase of bit rate. The relation between the noise and the picture of I-picture, P-picture and B-picture is as described above. Therefore, if the frame encoding information and bit rate information are respectively I-picture and low (lowest) bit rate that indicate that the most noise occurs (or noise tends to be highly visible), the amount of contour correction is the minimum (1) by referring to the table of FIG. 4. If the frame encoding information and bit rate information are respectively P-picture or B-picture and high (highest) bit rate that indicate that the least noise occurs (or noise tends not to be conspicuous), the amount of contour correction is the maximum (5) by referring to the table. In this embodiment, five different amounts of contour correction, or five stepwise amounts of 1 ~ 5 are used for the combinations of bit rate information and frame encoding information as listed on the table of FIG. 4. In other words, these amounts of contour correction are determined by supposing the amounts of noise caused according to the type of frame encoding information and the degree of bit rate.

The control circuit 11 is supplied with the additional information 25 from the information

detection/separation circuit 2, and selects the corresponding amounts of contour correction by using the frame encoding information and bit rate information contained within the additional information, and by
5 referring to the table of FIG. 4. If the frame encoding information and bit rate information are respectively I-picture and medium bit rate, "3" amount of contour correction is selected. The control circuit 11 supplies the control signal of this amount of
10 contour correction to the contour correction circuit 10a, thus controlling the amount of contour correction in the contour correction circuit 10a. Even if the additional information indicating other combinations is supplied, the same operation is made to correct for the
15 contour.

Thus, according to this embodiment, the contour correction is performed on the basis of the frame encoding information, so that it is possible to make appropriate contour correction. In addition,
20 since this embodiment makes the contour correction in accordance with the combination of the frame encoding information and bit rate information, more appropriate contour correction can be made on the basis of the type of frame encoding information and the degree of bit
25 rate. While five amounts of contour correction are used in the example of FIG. 4, it is not limited to those amounts, but may be properly changed if necessary.

In addition, while the contour correction is made for each frame in this embodiment, it may be made for a unit of a certain time (for example, over a few frame periods to dozens of frame periods or above).

5 For example, the ratios among the number of I-pictures, P-pictures and B-pictures within a certain time (for example, 10 frame periods to dozens of frame periods) are measured. If the ratio of I-pictures to the other pictures is larger as a result of the measurement, the

10 contour correction is controlled to be weak over all the frames of that certain period (namely irrespective of I, P and B pictures). On the contrary, when the ratio of I-pictures is smaller, the contour correction is controlled to be strong. The value of noise

15 appearance in the moving picture is determined as an average over these frames. Therefore, even if the ratio of particular frame encoding information is estimated over the certain period mentioned above, and used to control the contour correction, the same effect

20 can be achieved. Moreover, the control using this ratio and the control for each frame mentioned above may be combined.

[Embodiment 2]

The second embodiment according to the

25 invention will be described with reference to FIGS. 5 and 6. As illustrated in FIG. 5, the picture quality correction circuit 10 includes a noise reduction circuit 10b for reducing the noise of the image data

produced from the scan converter 7. This noise
reduction circuit 10b has, for example, a low-pass
filter or a core ring portion for suppressing an output
signal of very small amplitude to substantially zero so
5 that the amount of noise reduction can be controlled by
properly changing the coefficients of the low-pass
filter or the amount of core ring of the core ring
portion. In this embodiment, the control circuit 11
using the frame encoding information and bit rate
10 information controls this amount of noise reduction.
The control circuit 11 is supplied with the additional
information 25 separated by the information
detection/separation circuit 2. This additional
information contains the above-mentioned frame encoding
15 information and bit rate information.

As described above, the I-picture has a
characteristic of easily causing block noise and
mosquito noise while the B-picture and P-picture have
characteristics of not easily causing block noise and
20 mosquito noise as compared with the I-picture. In
addition, the noise is increased with the decrease of
the bit rate, and decreased with the increase of the
bit rate. Considering these characteristics of the
picture types and bit rate to the noise, the control
25 circuit 11 according to this embodiment has a table
that specifies the association among the type of frame
encoding information, the degree of bit rate
information and the amount of noise reduction as shown

in FIG. 6. If the frame encoding information and bit rate information are respectively I-picture and low (lowest) bit rate that indicate that the most noise occurs (or noise is easy to be conspicuous), the amount of noise reduction is the maximum (5) by referring to this table. If the frame encoding information and bit rate information are respectively P- or B-picture and high (highest) bit rate that indicate that the least noise occurs (or noise is not easy to be conspicuous), the amount of noise reduction is the smallest (1) by referring to the table. In other words, the resulting control characteristic is opposite to that resulting from the contour correction processing mentioned in the first embodiment. In this embodiment, five stepwise amounts of noise reduction, or five steps of 1 ~ 5 are used on the basis of the combination of the bit rate information and frame encoding information as will be seen from the table of FIG. 6. That is, these amounts of noise reduction are determined by supposing the extent of noise according to the type of frame encoding information and the degree of bit rate.

The control circuit 11 selects the corresponding amount of noise reduction by using the frame encoding information and bit rate information contained in the inputted additional information 25 by referring to the table of FIG. 6. If the frame encoding information and the bit rate information are respectively I-picture and medium bit rate, "3" amount

of noise reduction is selected. Then, the control
circuit 11 supplies the control signal of this amount
of noise reduction to the noise reduction circuit 10b,
thus controlling the amount of noise reduction in the
5 noise reduction circuit 10b. Even if the additional
information of other combinations is supplied, the
noise reduction processing is made by the same
operation.

Thus, according to this embodiment, the noise
10 reduction processing is performed on the basis of the
combination of the frame encoding information and bit
rate information, and thus appropriate noise reduction
processing can be made in accordance with the type of
frame encoding information and the degree of bit rate.
15 While five stepwise amounts of noise reduction are used
in the example of FIG. 6, the amount of noise reduction
is not limited to those values, but may be arbitrary
values if necessary.

[Embodiment 3]

20 The third embodiment of the invention will be
described with reference to FIGS. 7 and 8. The third
embodiment is the combination of the first and second
embodiments. In other words, this embodiment makes the
contour correction and noise reduction by using the
25 frame encoding information and bit rate information.
Referring to FIG. 7, the picture quality correction
circuit 10 includes the noise reduction circuit 10b for
making the noise reduction processing on the image data

produced from the scan converter 7, and the contour correction circuit 10a for making the contour correction processing on the output data produced from the noise reduction circuit 10b. The detailed constructions of the contour correction circuit 10a and noise reduction circuit 10b have been described above, and thus will not be mentioned here. In addition, the extent of noise depending upon the type of frame encoding information and the degree of bit rate is as described above, and thus will not be described here.

This embodiment is different from the first and second embodiment in that the control circuit 11 supplies control signals to the contour correction circuit 10a and noise reduction circuit 10b and that the table to be used as shown in FIG. 8 is produced by the combination of the tables of FIGS. 4 and 6. In other words, the table of FIG. 8 specifies the association among the combination of the frame encoding information and bit rate information, the amount of noise reduction and the amount of contour correction. The amount of noise reduction and the amount of contour correction are respectively specified in five steps of 1 - 5.

The control circuit 11 is supplied with the additional information 25 separated by the information detection/separation circuit 2. This additional information contains the above-mentioned frame encoding information and bit rate information. The control

circuit 11 selects the corresponding amount of noise reduction and amount of contour correction by using the inputted frame encoding information and bit rate information and by referring to the table of FIG. 8.

5 If the frame encoding information and bit rate information are respectively B-picture and low bit rate, the control circuit selects "4" amount of noise reduction and "2" amount of contour correction. Then, the control circuit 11 supplies the control signal of
10 this amount of noise reduction to the noise reduction circuit 10b, and the control signal of this amount of contour correction to the contour correction circuit 10a. Thus, it can control the amount of noise reduction in the noise reduction circuit 10b and the
15 amount of contour correction in the contour correction circuit 10a. Even if the additional information of other combinations is supplied, the noise reduction and contour correction processing can be performed by the same operation.

20 Thus, according to this embodiment, for the image containing much noise (I-picture and low bit rate) the amount of noise reduction is increased and the contour correction is weakened, but for the image containing less noise (B/P picture and high bit rate)
25 the amount of noise reduction is decreased and the contour correction is intensified. Therefore, according to this embodiment, the noise reduction processing and the contour correction can be

cooperatively controlled, and as a result the noise can be suppressed so that the image can be displayed with clear contour and high quality. While the amount of noise reduction is specified in five steps in the example of FIG. 8, it is not limited to those values, but may take various values if necessary.

[Embodiment 4]

The fourth embodiment of the invention will be described with reference to FIGS. 9 through 11. While the first through third embodiments are examples of using the additional information to control the picture quality correction, this fourth embodiment controls progressive scan conversion processing by using the additional information. In other words, this embodiment uses pull-down phase information as the additional information and the control circuit 11 to control the progressive scan processing in the scan converter 7 of the image processor 3. FIG. 10 shows an example of the construction of the scan converter 7 in this embodiment. The scan converter 7 includes an I/P converter circuit 7a for converting the interlace scan image data to progressive scan image data (progressive conversion), and delay circuits 7b and 7c for delaying the image by one field. FIG. 11 shows an example of the operation. The operation of this embodiment will be described by taking an example of processing the image data of a movie source that is previously processed in a 2-3 pull-down manner.

The 2-3 pull-down processing and the progressive scan conversion for the processed data will be first described with reference to FIG. 9. The movie source is originally 24 frames per second (images 50, 51). The image displayed in the area where a television broadcast of NTSC system is received as in Japan is about 60 frames per second. Thus, a cycle of repeating the same frame (image 50) three times and the next frame (image 51) twice is periodically processed so that the frame rate is increased up to 60 frames per second (this is called the 2-3 pull-down processing). In addition, since the broadcast image is chiefly of the interlace scan type, the movies source is converted to the interlace scan type at the same time that it undergoes the pull-down processing (50a ~ 50c, and 51d, 51e). The display apparatus that receives these images operates to produce the same image frames as before the conversion to interlace scan type. As indicated on the bottom side of FIG. 9, the images 50a and 50b, for example, are processed to convert to the progressive scan type as an image 501. Similarly, an image 502 is obtained from images 50a and 50b, an image 503 from images 50b and 50c, and images 511 and 512 from images 51d and 51e. In this way, the conversion of 60 frames to the progressive scan type is performed without mixing the images of adjacent frames of the original movie source. Thus, the resulting images can be displayed without picture quality deterioration. When

the above conversion to the progressive scan type is performed, this embodiment controls the processing of converting to the progressive scan type by using the pull-down phase information (2-3 pull-down information
5 in the example of FIG. 9) contained in the additional information 25. This processing will be described in detail with reference to FIG. 1 and FIGS. 9 through 11. Hereinafter, the image data is assumed to be of the interlace scan type. This embodiment is assumed to
10 operate when the decoded data is of the interlace scan type.

First, referring to FIG. 1, the information detection/separation circuit 2 separates each of the decoded data 6a and 6b into image data 24 and
15 additional information 25 that contains 2-3 pull-down phase information. The image data 24 is supplied to the scan converter 7 of the image processor 3. The image data 24 fed to the scan converter 7 is led to a point A of the I/P converter 7a and inputted thereto in
20 the order of fields 50a, 50b, 50c... as shown in FIG. 11. Reference numerals 50a, 50b, 50c... shown in FIG. 11 represent the fields fed in turn, and correspond to those of the interlace scan type image of 60 frames per second shown in FIG. 9. The 1-field delay circuits 7b
25 and 7c produce data shown in FIG. 11 at B and C and supply them to the I/P converter 7a, respectively. Thus, three pieces of image data, A, B and C are fed to the I/P converter 7a.

On the other hand, the additional information
25 containing the 2-3 pull-down phase information from
the information detection/separation circuit 2 is
supplied to the control circuit 11. This phase
5 information, as for example, shown in FIG. 11, is
assumed to reverse its signal level at point A between
the period of image data 50a through 50c and the period
of image data 51a through 51b. In other words, the
phase information turns over in its phase between the
10 three-field period and the two-field period of the 2-3
pull-down image information. The control circuit 11
uses this phase information to generate a control
signal D shown in FIG. 11. This control signal D can
be obtained by, for example, computing the exclusive
15 logic sum (logic 2 shown in FIG. 11) of the phase
information and a one-field delayed signal (logic 1
shown in FIG. 11) of this phase information and
delaying it by one field. The control signal D thus
produced is supplied to the I/P converter 7a. The I/P
20 converter 7a, when the control signal D is at high
level, converts image data A and B to the progressive
scan type, and when the control signal D is at low
level, converts image data B and C to the progressive
scan type. As a result, the conversion to the
25 progressive scan type can be made so that the images of
the adjacent frames of the original movie can be
prevented from being mixed as explained with reference
to FIG. 9. In this embodiment, when the image data is

originally of the progressive scan type, the conversion to the progressive scan type is not carried out.

Thus, since this embodiment uses the pull-down phase information to control the conversion to the progressive scan type, it is not necessary to detect the difference between the frames of the interlace scan type image in order to obtain the pull-down phase information of the image signal. Therefore, even if the image has much still portions or little signal level difference, the pull-down phase information can be substantially accurately obtained. Thus, according to this embodiment, the conversion to the progressive scan type can be performed with high precision. The levels of the signals shown in FIG. 11 are an example. Even if the high level and low level of each signal are reversed, the same operation can be achieved by reversing the operation of the progressive scan converter 7. While the image data that underwent the 2-3 pull-down process is applied to the operation of this embodiment, 2-2 pull-down or other pull-down systems may be similarly used in this embodiment.

[Embodiment 5]

The fifth embodiment of this invention will be described with reference to FIGS. 12 through 14. In the fifth embodiment, the image that underwent the 2-3 pull-down process is converted to the progressive scan type as in the above fourth embodiment, and then subjected to a motion compensation process. FIG. 12

shows an example of the construction of the scan converter 7 according to this embodiment. The scan converter 7 according to this embodiment includes the I/P converter 7a for converting the inputted image data to the progressive scan type, the delay circuit 7b for delaying the image data 24 by one field, the delay circuit 7c for delaying the output signal from the I/P converter 7a by one field, a delay circuit 7d for delaying the output signal from the delay circuit 7c by two fields, and a motion compensator 7e for compensating for the motion of the output signals from the delay circuits 7c and 7d. FIGS. 13 and 14 show an example of the operation. The operation of this embodiment will be described with reference to FIG. 1 and FIGS. 12 through 14. In the later description, the image data is assumed to be of the interlace scan type that underwent 2-3 pull-down process as for example shown in FIG. 9. This embodiment is assumed to operate when the decoded data is of the interlace scan type.

First, referring to FIG. 1, the information detection/separation circuit 2 separates each of the decoded data 6a and 6b into the image data 24 and the additional information 25 containing the pull-down phase information. The image data 24 is supplied to the scan converter 7 of the image processor 3. The image data 24 fed to the scan converter 7 is led to the point A of I/P converter 7a shown in FIG. 12. The image data 24 is also delayed one field by the delay

circuit 7b and led to a point B of the I/P converter 7a. The image data at points A and B are shown as "IMAGE DATA (A)" and "1-FIELD DELAY (B)" in FIG. 13.

On the other hand, the additional information
5 25 containing the pull-down phase information that is separated by the information detection/separation circuit 2 is supplied to the control circuit 11. The input signal to this control circuit is shown as "PHASE INFORMATION APPLIED" that indicates the phase at point
10 A for the 2-3 pull-down process made on the image data. The control circuit 11 produces the control signal (D) as in the operation mentioned with reference to FIG. 9. The I/P converter 7a, when the control signal (D) is at high level, converts the image data A and B to the
15 progressive scan type, and supplies the converted image data to the delay circuit 7c. The delay circuit 7c writes in the image data only when the control signal (D) is at high level as shown at "IP CONVERSION OUTPUT" in FIG. 13. Then, as shown in FIG. 13 at "1-FIELD
20 DELAY (G)", the image data within the delay circuit 7c is read out every fields, and supplied to point G of motion compensator 7e and to the 2-field delay circuit 7d. The image data within the delay circuit 7c, when the image data is not written in (namely, when the
25 control signal (D) is at low level), is repeatedly read every field. Therefore, as shown in FIG. 13 at (G), the image data of the first field F1 is delayed 1 field and read repeatedly thrice, and then the image data of

the second field F2 is delayed 1 field and read repeatedly twice. The image data of the third field F3 and the following are similarly processed, or the thrice reading of same data and twice reading of next
5 same data are periodically performed. The image data read from the delay circuit 7c is delayed 2 fields by the delay circuit 7d, and then led to a point H of the motion compensator 7e. The image data at point H is shown as "2-FIELD DELAY (H)" in FIG. 13.

10 The motion compensator 7e receives the output (G) from the delay circuit 7c and the output (H) from the delay circuit 7d, detects the motion vector between the two images, and compensates for the motion. FIG. 14 shows one example of the specific processing. In
15 FIG. 14, the abscissa is time, and the ordinate is the position on the screen. F1, F2 and F3 in FIG. 14 correspond to the image data F1, F2 and F3 shown in FIG. 13, respectively. The black circles shown in FIG. 14 indicate points (objects) moving on the screen over
20 a certain time. Before the motion compensation according to this embodiment is performed, these objects move on the screen in the order of P1, P2 and P3. In other words, the above objects are located on the screen at position P1 during the time when the
25 field F1 is being displayed repeatedly thrice, at position P2 during the time when the field F2 is being displayed repeatedly twice, and at position P3 during the time when the field F3 is being displayed

repeatedly thrice. That is, while the same field is being repeated, the objects are located at the same position. Therefore, the amount of motion of the objects between the adjacent fields becomes large, and
5 thus the motion of objects on the screen is not visually smooth.

Thus, in this embodiment, the motion information of objects between the adjacent fields is detected and used to compensate for the motion of the
10 image data of repeated fields, thereby making the (visual) object motion smooth. For example, the secondly appearing field of the thrice repeated fields F1 is compensated for the motion by using the motion information detected from the difference to the
15 adjacent field F2 so that the object located at position P1 can be moved to the position P11. Thus, a new field F11 is obtained by this motion compensation. Similarly, the thirdly appearing field is compensated for the motion by using the motion information detected
20 from the difference to the adjacent field F2 (or F11 or both) so that the object located at position P1 can be moved to the position P12 (indicated by a white circle). A new field F12 is obtained by this motion compensation. The same operation is made for the
25 twice-repeated fields F2. For example, the secondly appearing field of the repeated fields F2 is compensated for the motion by using the motion information detected from the difference to the

adjacent field F3 (or F1 or both) so that the object located at the position P2 can be moved to a position P21. A new field F21 is obtained by this motion compensation. The same operation is made for the field
5 F3. The objects located at position P3 are moved to positions P31 and P32 by the motion compensation, and thus new fields F31 and F32 are obtained. As a result, the motion compensator 7e produces image data in the order of F1, F11, F12, F2, F21... as shown in FIG. 13
10 at "IMAGE DATA PRODUCED". Therefore, as illustrated in FIG. 14, the motion of objects on the screen can be approximated to the one-dot chain line L that extends in the diagonal direction, and thus the amount of motion of objects between fields can be reduced. Thus,
15 according to this embodiment, the motion of images displayed can be made smooth.

While the motion compensator 7e in this embodiment detects the motion vector for the motion compensation, the motion vector information contained
20 in the additional information 25 can be used. In other words, it is possible that the control circuit 11 of the construction example shown in FIG. 12 is provided with a function to supply a control signal to the motion compensator 7e, and that the motion compensator
25 7e is provided with a function to make motion compensation on the basis of this control signal. Specifically, the motion vector information contained in the additional information 25 is supplied to the

control circuit 11, and the control circuit 11 generates the control signal on the basis of this motion vector information and supplies it to the motion compensator 7e. The motion compensator 7e makes the
5 above-mentioned motion compensation according to the motion vector information contained in the control signal fed from the control circuit 11. This construction does not need to detect the motion vector for the motion compensation. Since the motion vector
10 is given to a block unit of 8×8 pixels in the MPEG stream, the motion compensation may be made for each unit of 8×8 pixels.

Thus, according to the embodiments of the invention, it is possible to display high-quality
15 images. The first to sixth embodiments may be arbitrarily combined.

It should be further understood by those skilled in the art that although the foregoing description has been made on embodiments of the
20 invention, the invention is not limited thereto and various changes and modifications may be made without departing from the spirit of the invention and the scope of the appended claims, as interpreted by the description and drawings. !

Additional features of the invention are discussed in the following clauses:

1. An image display apparatus comprising:
 - an input unit to which a digital image signal is applied;
 - a detector which detects additional information inputted together with said digital image signal; and
 - a contour-correcting unit for correcting the contour of said image signal by using said additional information detected by said detector.
2. An image display apparatus comprising:
 - an input unit to which a digital image signal is applied;
 - a detector which detects frame encoding information that is added to each frame of said digital image signal and inputted together with said digital image signal; and
 - a contour-correcting unit for correcting the contour of said digital image signal by using said frame-encoding information detected by said detector.
3. An image display apparatus according to clause 2, wherein said digital image signal is a compressed and encoded digital image signal.
4. An image display apparatus according to clause 2, wherein said digital image signal is a digital image signal compressed and encoded according to an MPEG system.
5. An image display apparatus according to clause

2, wherein said detector detects as said frame encoding information an I-picture produced by intra-frame encoding of a current frame, a P-picture produced encoded by using the previous frame, or a B-picture produced encoded by using the previous frame and the next frame.

6. An image display apparatus according to clause 5, wherein said contour correcting unit corrects more amount for the contour of said P-picture frame or B-picture frame detected by said detector than for the contour of said I-picture frame detected.

7. An image display apparatus according to clause 2, further comprising:

a noise-reducing unit for reducing the noise of said image signal by using said frame-encoding information detected by said detector.

8. An image display apparatus comprising:

an input unit to which a digital image signal is applied;

a detector which detects frame encoding information added to each frame of said image signal and bit rate information of said image signal, said frame encoding information and said bit rate information being supplied together with said digital image signal; and

a picture quality correcting unit for making picture quality correction by using said frame encoding information and said bit rate information detected by

said detector.

9. An image display apparatus according to clause 8, wherein said picture quality correcting unit includes a contour correcting unit for making contour correction and/or a noise reducing unit for making noise reduction processing, both operations being made in accordance with a combination of said frame encoding information and said bit rate information.

10. An image display apparatus according to clause 8, wherein said detector detects as said frame encoding information an I-picture produced by intra-frame encoding of a current frame, a P-picture produced encoded by using the previous frame or a B-picture produced encoded by using the previous frame and the next frame.

11. An image display apparatus according to clause 10, wherein said picture quality correcting unit includes a contour correcting unit for making contour correction by using said frame encoding information and said bit rate information,

said contour correcting unit corrects more amount for said image signal that indicates the highest bit rate as said bit rate information detected by said detector, and indicates said P-picture or B-picture detected as said frame encoding information by said detector than for said image signal that indicates the lowest bit rate as said bit rate information detected by said detector and indicates said I-picture as said

frame encoding information detected.

12. An image display apparatus according to clause 10, wherein said picture quality correcting unit includes a contour correcting unit for making contour correction by using said frame encoding information and said bit rate information, and

said contour correcting unit corrects least amount for said image signal that indicates the lowest bit rate as said bit rate information detected by said detector and indicates said I-picture as said frame encoding information detected, but corrects most amount for said image signal that indicates the highest bit rate as said bit rate information detected by said detector and that indicates said P-picture or B-picture as said frame encoding information detected.

13. An image display apparatus according to clause 10, wherein said picture quality correcting unit includes a noise reducing unit for making noise reduction by using said frame encoding information and said bit rate information, and

said noise reducing unit reduces more amount the noise of the image signal that indicates the lowest bit rate as said bit rate information detected by said detector and indicates said I-picture as said frame encoding information detected than the amount of contour correction for said image signal that indicates the highest bit rate as said bit rate information detected by said detector and indicates said P-picture

or B-picture as said frame encoding information detected.

14. An image display apparatus according to clause 10, wherein said picture quality correcting unit includes a noise reducing unit for making noise reduction processing by using said frame encoding information and said bit rate information, and

said noise reducing unit reduces the most amount the noise of said image signal that indicates the lowest bit rate as said bit rate information detected by said detector and indicates said I-picture as said frame encoding information detected, but reduces the least amount for the noise of said image signal that indicates the highest bit rate as said bit rate information detected by said detector and indicates said P-picture or B-picture as said frame encoding information detected.

15. A digital television broadcast receiving apparatus comprising:

a tuner which receives a data stream including a compressed and encoded digital image signal as said television broadcast signal;

a decoder which decodes said stream received by said tuner;

a contour correcting unit for correcting the contour of said image signal decoded by said decoder; and

a control unit for controlling said contour

correcting unit by using frame encoding information that is added to each frame of said image signal and that is reproduced when said decoder decodes said image signal.

16. A digital television broadcast receiving apparatus comprising:

a tuner which receives a data stream including a compressed and encoded digital image signal as said television broadcast signal;

a decoder which decodes said stream received by said tuner;

a picture quality correcting unit for correcting the picture quality of said image signal decoded by said decoder; and

a control unit for controlling the amount that said picture quality correcting unit corrects by using frame encoding information added to each frame of said image signal and bit rate information of said stream, said frame encoding information and said bit rate information being reproduced when said decoder decodes said image signal.

17. A digital television broadcast receiving apparatus according to clause 16, wherein said control unit controls the amount that said picture quality correcting unit corrects in accordance with a combination of said frame encoding information and said bit rate information.

18. A digital television broadcast receiving

apparatus according to clause 17, wherein said picture quality correcting unit includes a contour correcting unit for correcting the contour of said image and/or a noise reducing unit for reducing the noise of said image, both operations being made in accordance with said combination.

19. A digital television broadcast receiving apparatus according to clause 16, further comprising:

an I/P converter which converts said image signal to a progressive scan type signal when said decoded image signal is of an interlace scan type, wherein

in response to pull-down phase information of said image signal obtained at the time of decoding by said decoder, said control unit controls said I/P converter to make said progressive scan type conversion by using said pull-down phase information.

20. A digital television broadcast receiving apparatus according to clause 16, further comprising:

an I/P converter which converts said image signal to a progressive scan type signal when said decoded image signal is of an interlace scan type; and

a motion compensator which compensates for the motion of an output signal from said I/P converter, wherein

in response to pull-down phase information of said image signal and motion vector information of said stream obtained at the time of decoding by said

decoder, said control unit controls said I/P converter to make said progressive scan type conversion on the basis of said pull-down phase information, and said motion compensator to compensate on the basis of said motion vector information.

21. A digital television broadcast receiving apparatus comprising:

a tuner which receives a data stream including a compressed and encoded digital image signal as said television broadcast signal;

a decoder which decodes said stream received by said tuner;

an I/P converter which converts said image signal to a progressive scan type signal when said decoded image signal is of an interlace scan type; and

a control unit, wherein

in response to pull-down phase information of said image signal obtained at the time of decoding by said decoder, said control unit controls said I/P converter to make said progressive scan type conversion by using said pull-down phase information.

22. A digital television broadcast receiving apparatus comprising:

a tuner which receives a data stream including a compressed and encoded digital image signal as said television broadcast signal;

a decoder which decodes said stream received by said tuner;

an I/P converter which converts said image signal to a progressive scan type signal when said decoded image signal is of an interlace scan type;

a motion compensator which compensates for the motion of an output signal from said I/P converter;
and

a control unit, wherein

in response to pull-down phase information of said image signal and motion vector information of said stream obtained at the time of decoding by said decoder, said control unit controls said I/P converter to make said progressive scan type conversion on the basis of said pull-down phase information, and said motion compensator to compensate on the basis of said motion vector information.

CLAIMS:

1. A digital television broadcast receiving apparatus comprising:

5 a tuner which receives a data stream including a compressed and encoded digital image signal as said television broadcast signal;

a decoder which decodes said stream received by said tuner; an I/P converter which converts said image signal
10 to a progressive scan type signal when said decoded image signal is of an interlace scan type; and

a control unit, wherein

in response to pull-down phase information of said image signal obtained at the time of decoding by said
15 decoder, said control unit controls said I/P converter to make said progressive scan type conversion by using said pull-down phase information.

2. A digital television broadcast receiving apparatus comprising:

20 a tuner which receives a data stream including a compressed and encoded digital image signal as said television broadcast signal;

a decoder which decodes said stream received by said tuner;

25 an I/P converter which converts said image signal to a progressive scan type signal when said decoded image signal is of an interlace scan type;

a motion compensator which compensates for the motion of an output signal from said I/P converter; and a control unit, wherein

in response to pull-down phase information of said
5 image signal and motion vector information of said stream obtained at the time of decoding by said decoder, said control unit controls said I/P converter to make said progressive scan type conversion on the basis of said pull-down phase information, and said motion compensator
10 to compensate on the basis of said motion vector information.

43

Application No: GB0606100.6
 Claims searched: 1 & 2

Examiner: Matthew Males
 Date of search: 5 June 2006

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1	US 6055018 A SWAN - see col. 2, lines 23-44.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^x :

H4F

Worldwide search of patent documents classified in the following areas of the IPC

H04N

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, TXTUS0, TXTUS1, TXTUS2, TXTUS3, TXTEP1, TXTGB1, TXTWO1, TXTAU1, INSPEC