(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 443 487 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
15.08.2012 Bulletin 2012/33

(21) Application number: **02802739.9**

(22) Date of filing: **11.11.2002**

(51) Int Cl.:
G09G 3/36 $^{(2006.01)}$ ***G09G 3/20*** $^{(2006.01)}$
G02F 1/133 $^{(2006.01)}$ ***H04N 5/66*** $^{(2006.01)}$

(86) International application number:
PCT/JP2002/011746

(87) International publication number:
WO 2003/041044 (15.05.2003 Gazette 2003/20)

(54) Liquid Crystal Display Device

Flüssigkristall-Anzeigevorrichtung

Ecran à cristaux liquides

(84) Designated Contracting States:
DE ES FR

(30) Priority:

09.11.2001	**JP 2001344078**
20.08.2002	**JP 2002238956**
29.08.2002	**JP 2002250201**
04.09.2002	**JP 2002258826**
04.09.2002	**JP 2002258827**
24.09.2002	**JP 2002277488**
26.09.2002	**JP 2002280964**
28.10.2002	**JP 2002312265**

(43) Date of publication of application:
04.08.2004 Bulletin 2004/32

(73) Proprietor: **Sharp Kabushiki Kaisha**
Osaka-shi, Osaka 545-8522 (JP)

(72) Inventors:
- **SUGINO, Michiyuki**
Chiba-shi, Chiba 267-0066 (JP)
- **KIKUCHI, Yuji**
Kuroiso-shi, Tochigi 329-3146 (JP)
- **OSADA, Toshihiko**
Yaita-shi, Tochigi 329-2141 (JP)
- **YOSHII, Takashi**
Yaita-shi, Tochigi 329-2141 (JP)
- **SHIOMI, Makoto**
Tenri-shi, Nara 632-0093 (JP)

(74) Representative: **Müller - Hoffmann & Partner**
Patentanwälte
Innere Wiener Strasse 17
81667 München (DE)

(56) References cited:
JP-A- 3 096 993 **JP-A- 4 288 589**
JP-A- 9 106 262 **US-A- 5 119 084**

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Printed by Jouve, 75001 PARIS (FR)

Description

Technical Field

[0001] The present invention relates to a liquid crystal display for image display using a liquid crystal display panel, and in particular relates to a liquid crystal display wherein the optical response characteristic of the liquid crystal display panel can be improved.

Background Art

[0002] Recently, as personal computers and television receivers have become lighter and thinner, reduction in thickness and weight of display devices has also been wanted. In answer to such demands , flat panel type displays such as liquid crystal displays (LCDs) have been developed in place of cathode ray tubes (CRTs).

[0003] An LCD is a display device which produces desired image signals by applying electric fields across a liquid crystal layer having anisotropic dielectric constants, injected between a pair of substrates so that the strength of the electric fields is controlled to thereby control the amount of light passing through the substrates. Such LCDs are typical examples of handy flat panel type displays. Of these, TFT LCDs that employ thin-film transistors (TFT) as switching elements are mainly in use.

[0004] Lately, since LCDs have been not only used as the display devices of computers but also used widely as the display devices of television receivers, the need for rendering motion pictures has been increased. However, since the conventional LCDs are low in response speed, they have a drawback that it is difficult to reproduce motion pictures.

[0005] In order to make the LCD's response speed problem better, there is a known liquid crystal driving method wherein in accordance with the combination of the input image data of the previous frame and the input image data of the current frame, either a higher (overshot) drive voltage than the predetermined gray scale level voltage that corresponds to the input image data of the current frame or a lower (undershot) drive voltage is supplied to the liquid crystal display panel. In this specification of the present application, this driving scheme should be defined as overshoot (OS) drive.

[0006] Fig.1 shows a schematic configuration of a conventional overshoot drive circuit. Specifically, the input image data (current data) of the N-th frame being about to be displayed and the input image data (previous data) of the (N-1) -th frame being stored in a frame memory 1 are loaded into an emphasis converter 2, wherein the patterns of the gray scale level transitions between both the data and the input image data of the N-th frame are looked up with the applied voltage data table stored in a table memory (ROM) 3 so as to identify applied voltage data, and write-gray scale level data (emphasis-converted data) needed for image display of the N-th frame is determined based on the thus obtained applied voltage data (emphasis conversion parameters) so as to be supplied to a liquid crystal display panel 4. Here, emphasis converter 2 and table memory 3 constitute a write-gray scale level determining means.

[0007] The applied voltage data (emphasis conversion parameters) stored in the above table memory 3 is obtained beforehand from the actual measurement of the optical response characteristics of liquid crystal display panel 4. When, for example, the number of display signal levels , i.e., the amount of display data, is 256 gray scales represented by 8 bits, every level of 256 gray scales may have a piece of applied voltage data, as shown in Fig.2. Alternatively, it is also possible that only the measurements for nine representative gray scale levels, one for every 32 gray scale levels, have been stored and the applied voltage data for other gray scale levels is determined by linear interpolation of the above measurements or other operations.

[0008] There has been a problem in that it takes long time to make a transition from a certain half gray scale level to another half gray scale level, so that it is impossible for a general liquid crystal display panel to display the half gray scales within the period of one frame (e.g., 16.7 msec. for a case of progressive scan of 60 Hz). This not only produces afterglow but also hinders correct half gray scale display. Use of the above-described overshoot drive circuit, however, enables display of the aimed half gray scale level within a short time as shown in Fig.3.

[0009] In the case where the liquid crystal response speed is improved by way of the signal processing as above, OS drive is performed by making a comparative operation between the input image data of the previous frame and the current frame data and outputting the emphasis-converted data.

[0010] However, if the emphasis-converted data is mis-optimized, errors in data between frames are enhanced, so that video noise which does not originate from due input data will be generated. Figs.4 and 5 show the relationships between the applied voltage to the liquid crystal display panel and the transmittance when the input video data changes from black to a certain half gray scale value.

[0011] Since in Fig. 4 the emphasis-converted data is optimized in conformity with the liquid crystal display panel characteristic, the target brightness can be realized within one frame, while three frames are needed for the normal drive to reach the target brightness. On the other hand, shown in Fig.5 is a case where the brightness reaches a level higher than the target because excessive emphasis-converted data is used.

[0012] Since the cases explained with reference to Figs. 4 and 5 are assumed that the input image data changes from black to a certain half gray scale level and continues to be set at that half gray scale level, the output data reaches the target brightness level while the error of the output data is absorbed within one frame. However, if the input data changes repeatedly, e.g., black → half gray scale → black → half gray scale, the error will rapidly increase.

[0013] In terms of normally received television signals this problem causes undue images (so-called noise) that are laid over edges such as face contours, character contours, etc., resulting in image degradation such as unnatural hue, white spots, flickering, etc.

[0014] Further, when the response speed of the liquid crystal display panel is taken into consideration, it is difficult to output the optimal emphasis-converted data at any time because of variations in cell gap, change in the viscosity of the liquid crystal material due to ambient temperature and other factors.

[0015] Further, since in the conventional liquid crystal display shown in Fig.1, the input image data for the current frame is emphasis-converted and supplied to the liquid crystal display panel, based on the gray scale level transitions of the input image data from one frame to the next, if some noise is laid over the input image data, the noise also is emphasis-converted and supplied to the liquid crystal display panel, causing image degradation such as white spots, flickering etc., resulting from the emphasized noise.

[0016] Fig.6 is an illustrative view showing a case where noise is laid over 3x3 pixels of data. For instance, suppose that noise shown in Fig.6(b) is added (the pixels of the 135th and 130th gray scale levels are the noise added portions) when data of the 128th gray scale level is supplied to all the pixels as shown in Fig.6(a). In the normal drive mode, the input gray scale levels are output straight through, so that the display data (write-gray scale levels) shown in Fig.6(b) is displayed on the liquid crystal display panel.

[0017] On the other hand, when OS drive for data emphasis conversion is implemented, this affects the data to enlarge the transition width. So the noise added portions are emphasized to reach the 140th and 135th gray scale levels as shown in Fig.6(c), hence the noise is displayed prominently. In this way, if a signal source of a poor S/N ratio is supplied to an OS drive configuration, the noise is also emphasized more than that in the normal drive mode, this gives a problem in that the image quality of the displayed image is degraded.

[0018] To deal with this, Japanese Patent Application Laid-open No. Hei 3-96993, for example, proposes a configuration, wherein the differential signal as to the video data to be displayed on the liquid crystal display between the current data and the data one frame period or one field period before is detected, and when the magnitude of the differential signal is smaller than the predetermined level, the difference is determined to be noise and the input video data is output straight through, while, when the magnitude of the differential signal is greater than the predetermined level, the input video data is added with the above differential signal so as to output the video data with its afterimage removed.

[0019] This scheme is realized by provision of a coefficient circuit composed of a multiplier for multiplying the input signal by a predetermined coefficient or using a ROM table, having an input/output characteristic shown in Fig.7. More specifically, when the value of the differential signal (motion detection signal) between the pieces of data one frame period or one field period apart, to be supplied to the coefficient circuit, falls within the ranges from 0 to + a and from 0 to -a, or when the magnitude is smaller than the predetermined value |a|, the input video data is output straight through.

[0020] On the other hand, when the value of the differential signal (motion detection signal) supplied to the coefficient circuit falls outside of the ranges 0 to + a and 0 to -a, or when the magnitude is greater than the predetermined value |a|, the input signal multiplied by a coefficient having the same polarity as that of the input signal is output and added to the input video data, so that the input video data is emphasis-converted to cancel the afterimage from the image displayed on the LCD device.

[0021] However, in the above disclosure of Japanese Patent Application Laid-open No. Hei 3-96993, a coefficient circuit composed of the multiplier or the ROM table is used to obtain output video data in conformity with the magnitude of the differential signal of the video data between the current data and the data one frame period or one field period before, so it is only possible to deal with one-dimensional noise depending on temporal variations. Therefore it has been impossible to prevent image degradation of the displayed image, in a perfect manner.

[0022] In the conventional liquid crystal display shown in Fig. 1, when the emphasizing process (OS drive) by write-gray scale level determining portion 2 is implemented, noise and the like, which are high frequency components, superimposed on the input image data, are further emphasized by the OS drive, posing the image degradation problem in that noise stands out as white spots (in the case of the liquid crystal display panel operated in the normally black mode).

[0023] For example, playback of an analog VTR entails noise that is attributed to the tape and head system during signal reproduction, or playback of a tape that is obtained after repeated duplication results in a poor signal to noise ratio producing much noise. If the above-described OS drive is implemented for the input image data superimposed with such noise, even the noise is emphasized and results in image degradation of the displayed image.

[0024] Further, when a user who prefers a clear and vivid image adjusts the contour enhancement correcting function of a television system etc. , to a severe level, the contour enhanced portions are further emphasized by OS drive to a too strong level and unnatural hues, flickering, etc., arise, degrading the image quality of the displayed image.

[0025] Moreover, the video signals for DVD and digital broadcasting are compressed by MPEG-2. In MPEG, it is usually known that the lower the transfer bit rate of codes (the higher the compression rate), the more the coding noise stands out and the more the image quality degrades. As typical coding noise in MPEG, block noise and mosquito noise are well known.

[0026] Block noise is a phenomenon whereby boundaries of blocks appear clearly and are seen like tiles. This takes place when the image signal within each block has only low frequency components and the neighboring blocks have different frequency component values. Mosquito noise is flickering noise appearing around edges as if mosquitoes were flying. This noise is generated due to loss of high frequency components that are included in the original image signal, through quantization.

[0027] In this way, when coded image data that is encoded based on a coding scheme that implements blockwise orthogonal transformation is input/decoded to perform image display, block distortion whereby boundaries of process blocks appear in the flat portion of the decoded image, and mosquito noise that causes haze around edge portions of characters and contours occur. These noises are emphasized by OS drive; degrading the image quality of the displayed image.

[0028] Usually, at the previous stage of the aforementioned overshoot drive circuit, various video adjustments are implemented according to user's preference, hence OS drive (emphasis conversion process) is executed for the input image data which has undergone the video adjustments. Accordingly, depending on the video adjustment result, OS drive may pose a problem in that the image quality of the displayed image is degraded by the occurrence of the adverse effects (unnatural hues, flickering, etc.) therefrom.

[0029] For example, when a user who prefers a clear and vivid picture applies rather intensive contour enhancement correction by video adjustment, the contour enhanced portions are further emphasized by OS drive to a too strong level and produce white spots (in the case of a liquid crystal display panel operated in the normally black mode), unnatural hues, flickering and others, resulting in degradation of the image quality of the displayed image.

[0030] Since the optical response characteristics of liquid crystal display panels are different depending on the alignment mode of liquid crystal, the electrode structure for applying electric fields across the liquid crystal material and other factors, there exist some gray scale level transition patterns of which the liquid crystal response speed can be well improved by OS drive (emphasis conversion process) and others of which the liquid crystal response speed can not be improved very much by OS drive (emphasis conversion process).

[0031] When a picture obtained as a result of the user's video adjustments for input image data as to gray scale level characteristics such as black (white) extension, black (white) level adjustment, brightness adjustment and the like, includes many gray scale level transition patterns of which the liquid crystal response speed cannot be improved very much by OS drive (emphasis conversion process), implementation of OS drive only enlarges data errors between frames, resulting in generation of video noise which does not exist in the original input image data.

[0032] Illustratively, there are gray scale level transitions in which the target gray scale level cannot be achieved within one frame even if OS drive is effected. For such transitions, if OS drive is effected for the next frame, the applied voltage of data is determined on the basis that the previous gray scale level has reached the target gray scale level despite the fact the gray scale level has not yet been reached. As a result, gray scale levels which are deviated from due gray scale levels to be displayed are displayed, so that the desired image cannot be displayed. If this is repeated, the error of the output data increase rapidly, posing the problem in that whitened or blackened pixels are reproduced.

[0033] As it has been known that the response speed of liquid crystal greatly depends on the temperature, Japanese Patent Application Laid-open No.Hei4-318516,for example, discloses a liquid crystal display panel driver that continuously controls and keeps the response speed of gray scale change in an optimal condition without loss of display quality in order to deal with any change of the temperature of liquid crystal display panel.

[0034] This configuration includes: RAM for storing one frame of digital image data for display; a temperature sensor for detecting the temperature of the liquid crystal display panel; and a data converting circuit which compares the aforementioned digital image data with the image data that is read out, by a one-frame delay, from the RAM and, if the current image data has changed from the image data one frame before, implements emphasis conversion of the current image data in the direction of the change, in accordance with the detected temperature of the above temperature sensor, whereby display of the liquid crystal display panel is driven based on the image data output from this data converting circuit.

[0035] Specifically, suppose that the temperature of the liquid crystal display panel to be detected by the temperature sensor is classified into, for example, three ranges Th, Tm and Tl (Th > Tm > Tl) and three mode signals, corresponding to these ranges, to be output from the A/D converter to the data converting circuit are defined as Mh, Mm and Ml, while in the ROM of the data converting circuit, "3", the number equal to that of the mode signals, tables of image data, which can be accessed by designating the addresses or the value of the current image data and that of the image data delayed by one frame, are stored beforehand. One table which corresponds to the input mode signal is selected, and the image data stored in the table at the memory location designated by the addresses , i.e., the value of the current image data and that of the image data delayed by one frame is read out to be output to the drive circuit of the liquid crystal display panel.

[0036] Next, Fig.8 is a rear view showing a schematic configurational example of a direct backlight type liquid crystal display. In Fig.8, 4 designates a liquid crystal display panel, 11 fluorescent lamps for illuminating the liquid crystal display panel 4 from the rear, 12 an inverter transformer for energizing fluorescent lamps 11, 13 a power supply unit, 14 a video processing circuit board, 15 a sound processing circuit board and 16 a temperature sensor.

[0037] Of these, items releasing heat that greatly affects the response speed characteristic of liquid crystal display panel 4 are inverter transformer 12 and power supply unit 13. It is preferred that temperature sensor 16 is arranged inside liquid crystal display panel 4, from its due objective, but this is difficult, so the sensor should be attached to another member such as a circuit board.

[0038] Therefore, when, for example, the constituents 11 to 15 are arranged as shown in Fig. 8, temperature sensor 16 is attached to sound processing circuit board 15, which is least affected by generation of heat from inverter transformer 12 and power supply unit 13, and the detected output from this temperature sensor 16 is made use of by an overshoot drive circuit provided in video processing circuit board 14.

[0039] The above-described conventional liquid crystal display, however, has the following problems.

> (1) If, for example, the applied voltage data (emphasis conversion parameters) stored in OS table memory 3 is broken, or the calculation algorithm for linear interpolation or the like in emphasis converter 2 is broken, due to some device trouble, it becomes impossible to supply the liquid crystal display panel 4 with correct applied voltages of data (emphasis-converted data) corresponding to the input image data, whereby the image quality of the displayed image is markedly degraded, thus hindering the attention to the picture.
>
> (2) Further, in the case of the above-described conventional liquid crystal display, in the normal installed state (stand-mounted state) shown in Fig.9(a) temperature sensor 16 is arranged at the place where it has least influence of heat from inverter transformer 12, power supply unit 13 and other components. However, when the screen is set at the vertically inverted state (in the suspended state from ceiling) as shown in Fig.9(b) or when rotated by 90 degrees (in the portrait orientation state) as shown in Fig.9(c), the heat flow path changes hence temperature sensor 16 is significantly affected by generation of heat from the other members, so it is no longer possible to detect the exact temperature of liquid crystal display panel 4.

[0040] As a result, correct applied voltages of data (emphasis-converted data) corresponding to the temperature of liquid crystal display panel 4 cannot be supplied to liquid crystal display panel 4, causing the problem of image quality of the displayed image being significantly degraded by generation of shadow tailing due to application of insufficient applied voltages of data (emphasis-converted data) to liquid crystal display panel 4 or by generation of white spots due to application of excessive applied voltages of data (emphasis-converted data) to liquid crystal display panel 4 (in the case of the normally black mode).

[0041] Further, if this liquid crystal display is put in a place where air is blown onto it from a room air-conditioner or in a sunny place or direct sunshine, part of liquid crystal display panel 4 may decrease or increase in temperature, producing varying temperature distribution across the surface of liquid crystal display panel 4. Resultantly, excessive applied voltages of data (emphasis-converted data) may be supplied to liquid crystal display panel 4 in partial areas, producing white spots, or insufficient applied voltages of data (emphasis-converted data) may be supplied to liquid crystal display panel 4 causing shadow tailing (when in the normally black mode), hence image quality of the displayed image is significantly degraded. This problem of varying temperature distribution across the surface of liquid crystal display panel 4 depending on the place of installation becomes more noticeable when the display screen size becomes greater. (3) Moreover, when coded image data that is encoded based on a coding scheme that implements orthogonal transformation for every block consisting of, for example, M×N pixels, is input/decoded to perform image display, block distortion whereby boundaries of processed blocks appear in the flat portion of the decoded image, and mosquito noise that causes haze around edge portions of characters and contours occur, depending on the compression ratio of the image coded data. When overshoot drive is applied to these noises, the noises are emphasized, resulting in degradation of the image quality of the displayed image.

[0042] Similarly and also, in the case where a picture signal having a poor S/N ratio is input, the noise is emphasized when overshoot drive is effected, causing degradation of the image quality of the displayed image. In this way, depending on the property of the input image, overshoot drive causes adverse effect, thus degrading the image quality of the displayed image.

[0043] US 5,119,084 describes a liquid crystal display apparatus for driving a liquid crystal display panel in accordance with an image signal, wherein the response speed of the panel is increased so as not to produce an afterimage upon motion image display.

Disclosure of Invention

[0044] The present invention is configured as disclosed in independent claim 1.

Brief Description of Drawings

[0045]

> Fig.1 is a block diagram showing a schematic configuration of an overshoot drive circuit in a conventional liquid crystal display.
>
> Fig.2 is a schematic illustration showing one example of the table content in an OS table memory used

in an overshoot drive circuit.

Fig.3 is an illustrative view showing the relationship between the voltages applied to liquid crystal and the responses of the liquid crystal.

Fig.4 is a chart showing the relationship between the transmittance and the applied voltage when the optimal OS drive is realized in the prior art.

Fig.5 is a chart showing the relationship between the transmittance and the applied voltage when the optimal OS drive could not be realized in the prior art.

Fig.6 is an illustrative view showing display data when noise is laid over the input image data.

Fig.7 is an illustrative view showing the input/output characteristic of an afterimage cancellation circuit in a conventional liquid crystal display.

Fig.8 is an illustrative view showing a schematic configuration example of a direct backlight type liquid crystal display, viewed from the rear side thereof.

Fig.9 includes illustrative views of a liquid crystal display, (a) normal installed state, (b) vertically inverted state and (c) 90 degree rotated state.

Fig.10 a block diagram showing the schematic configuration of a first comparative example of a liquid crystal display.

Fig.11 is a block diagram showing an edge detecting circuit in the first example of a liquid crystal display .

Fig.12 is a block diagram showing a schematic configuration of important components in a second comparative example of a liquid crystal display.

Fig.13 a block diagram showing the schematic configuration of a third Comparative example of a liquid crystal display.

Fig.14 is an illustrative view showing the example of table content in ROM 21 (non-conversion table memory) in the third example of a liquid crystal display .

Fig.15 is a block diagram showing an edge detecting circuit in the third example of a liquid crystal display .

Fig.16 is an illustrative view showing another ROM configuration (table content example) in the third example of a liquid crystal display.

Fig. 17 is a block diagram showing a schematic configuration of important components in a fourth Comparative example of a liquid crystal display.

Fig.18 is a schematic illustration showing one example of ROM table content in the fourth example.

Fig.19 is a block diagram showing a noise detecting circuit in the fourth example.

Fig.20 is an illustrative view for explaining the noise detecting circuit in the fourth example.

Fig.21 is a block diagram showing a noise detecting circuit in a fifth Comparative example of a liquid crystal display

Fig.22 is a block diagram showing a schematic configuration of important components in the embodiment of the liquid crystal display of the present invention.

Fig.23 is a block diagram showing an example of a liquid crystal display in the embodiment.

Fig.24 is a block diagram showing a comparative example of a liquid crystal display.

Fig. 25 is a block diagram showing an example of a liquid crystal display in the embodiment.

Fig.26 is a block diagram showing an example of a liquid crystal display in the embodiment.

Fig.27 is a schematic illustration showing the table content in an OS table memory that stores high-level emphasis parameters used in the example.

Fig.28 is a schematic illustration showing the table content in an OS table memory that stores low-level emphasis parameters used in the example.

Fig.29 is a schematic illustration showing the table content in an OS table memory that stores non-conversion parameters used in the example.

Fig.30 is a schematic illustration showing the table content in an OS table memory that stores two kinds of emphasis parameters and non-conversion parameters used in the example.

Fig. 31 is a block diagram showing an example of a liquid crystal display in the embodiment.

Fig. 32 is a block diagram showing a comparative example of a liquid crystal display.

Fig.33 is a block diagram showing a comparative example of a liquid crystal display.

Fig.34 is a block diagram showing a schematic configuration of important components in a seventh comparative example of a liquid crystal display.

Fig.35 is a schematic illustration showing the table content of an OS table memory for use in the seventh example.

Fig.36 is a schematic illustrative view showing the optical response characteristic of a liquid crystal display panel for use in the seventh example.

Fig. 37 is a block diagram showing one example of a video processor (contour enhancement correcting circuit) in the seventh example.

Fig.38 is an illustrative chart showing another video processor example (gray scale level correction characteristic) in the seventh example.

Fig.39 is an illustrative chart showing still another video processor example (gray scale level correction characteristic) in the seventh example.

Fig.40 is a block diagram showing a schematic configuration of important components in an eighth comparative example of a liquid crystal display.

Fig.41 is a block diagram showing a schematic configuration of important components in a ninth comparative example of a liquid crystal display.

Fig.42 is a schematic illustration showing the table content of a weak-conversion table memory for use in the ninth example.

Fig.43 is a schematic illustration showing the table content of a non-conversion table memory for use in the ninth example.

Fig.44 is a block diagram showing a schematic configuration of important components in a tenth comparative example of a liquid crystal display.

Fig.45 is a schematic illustration showing the table content of a table memory for use in the tenth example.

Fig.46 is a block diagram showing a schematic configuration of important components in an eleventh comparative example of a liquid crystal display.

Fig.47 is a schematic illustration showing the table content of an OS table memory for use in the eleventh example.

Fig.48 is a block diagram showing another configurational example of a write-gray scale level means in the eleventh example.

Fig.49 is a block diagram showing a schematic configuration of important components in a twelfth comparative example of a liquid crystal display.

Fig.50 is a schematic illustration showing the table content of a non-conversion table memory for use in the twelfth example.

Fig.51 is a block diagram showing a schematic configuration of important components in a thirteenth comparative example of a liquid crystal display.

Fig.52 is a schematic illustration showing the table content of a table memory for use in the thirteenth example.

Fig.53 is a block diagram showing a schematic configuration of important components in a fourteenth comparative example of a liquid crystal display .

Fig.54 is a schematic illustration showing the table content of an OS table memory for use in the fourteenth example.

Fig.55 is a block diagram showing a configurational example of a write-gray scale level means in a fifteenth comparative example of a liquid crystal display .

Fig.56 is a block diagram showing a schematic configuration of important components in a sixteenth comparative example of a liquid crystal display .

Fig.57 is a schematic illustration showing the table content of a non-conversion table memory for use in the sixteenth example.

Fig.58 is a block diagram showing a schematic configuration of important components in a seventeenth comparative example of a liquid crystal display .

Fig.59 is a block diagram showing a schematic configuration of important components in an eighteenth comparative example of a liquid crystal display .

Fig.60 is a schematic illustration showing the table content of a table memory for use in the eighteenth example.

Fig.61 is a schematic illustration showing the table content of a table memory for use in a nineteenth comparative example of a liquid crystal display.

Best Mode for Carrying Out the Invention

[0046] The embodiment of the present invention will be described hereinbelow.

[0047] Now, a first comparative example of a liquid crystal display useful for understanding the invention will be described in detail with reference to Figs.10 and 11. The same components as those in the above-described conventional example are allotted with the same reference numerals and description for those is omitted. Here, Fig. 10 is a block diagram showing a schematic configuration of a liquid crystal display of this example, and Fig. 11 is a block diagram showing an edge detecting circuit in the liquid crystal display of the present example.

[0048] As shown in Fig.10, the liquid crystal display of the present example includes a delay circuit 33 for compensating the operation processing time of an emphasis converter 2 in order to make the input image data in phase, with respect to the time axis, with the emphasized data; an edge detecting circuit 50 for detecting edges within the input image data; and a selector 36 for selecting either the current field input image data or the emphasized data from the emphasis converter 2, pixel by pixel, based on the edge detection result from edge detecting circuit 50, and outputting the selected data as the display image data to a liquid crystal panel 4.

[0049] Emphasis converter 2 compares the current field image data with the image data one field before, output from an FM1, and reads out the emphasis conversion parameters corresponding to gray scale level transitions between both pieces of data from ROM 3 and determines the emphasized data (corrected image data) to be output to liquid crystal display panel 4 for all the gray scale level transitions, by implementing linear interpolation or other operations on the emphasis conversion parameters.

[0050] Next, a constitutional configurational example of edge detecting circuit 50 will be described with reference to Fig. 11. Though description herein will be given assuming that the input image data is an R signal of 8 bit data, obviously this will not limit the example. The input image data is latched by an 8 bit flip-flop (to be abbreviated as FF, hereinbelow) 51 and then by another flip-flop (to be abbreviated as FF, hereinbelow) 52. Here, these two blocks, FF 51 and FF 52, constitute a shift register.

[0051] Thereby, the relationship between the data held by FF 51 and the data held by FF 52 is that of neighboring pixels of data. Both the data held at FF 51 and FF52 are input to a subtracter 53 so that the difference between the neighboring pixels is supplied to a comparator 54. This comparator 54 compares the output from subtracter 53 with a reference data for comparison to verify whether the pixel is at an edge and outputs the comparison result as an edge detection result to selector 36.

[0052] In this way, it is possible to determine whether the current input pixel data is at an edge or not, and based on the detected result, selector 36 can select one from the current field input image data from delay circuit 33 and the emphasized data from the emphasis converter 2 and supply the selected one to liquid crystal display panel 4. Illustratively, when data "1" that represents the presence of an edge is input as the edge detection result, selector 36 directly outputs the current field input image data, which has not been emphasis-converted, as the pixel data to liquid crystal display panel 4.

[0053] As described above, according to the liquid crystal display of this example, accelerative drive is turned off and the normal drive is effected for the pixel areas that have been determined to belong to image edges. Therefore, adverse effects from the accelerative drive such as unnatural hues, white spots, flickering and the like occurring at and around edges can be removed, whereby it is possible to realize high-quality image display.

[0054] Here, though in the above first example the write-gray scale level determining means is constituted of ROM 3 and computing unit 2, a two-dimensional function f (pre, cur) defined by, for instance, two variables, i.e., the gray scale level before transition and the gray scale level after transition, may be provided instead of provision of ROM 3, so as to determine the corrected image data (emphasis-converted data) for compensating the optical response characteristic of liquid crystal display panel 4.

[0055] Next, a second comparative example of a liquid crystal display useful for understanding the invention will be described with reference to Fig. 12. The same components as those in the above first embodiment are allotted with the same reference numerals and description for those is omitted. Here, Fig.12 is a block diagram showing a schematic configuration of important components in the liquid crystal display of the present example.

[0056] The liquid crystal display of this example, instead of having selector 36 in the first example, includes: as shown in Fig.12, a subtracter 58 for subtracting the input image data from the corrected image data (emphasized data) obtained by emphasis converter 2; a multiplier 59 for multiplying the output data from the subtracter 58 by a weight coefficient k ($0 \leq k \leq 1$) ; and an adder 60 which adds the output data from multiplier 21 to the input image data so as to provide display image data.

[0057] Here, the weight coefficient k in multiplier 59 is variable based on the edge detection result from edge detecting circuit 50. Specifically, when data "0" that represents no edge detection is input as the edge detection result, the weight coefficient k is set at 1 so that the emphasized data is output to liquid crystal panel 4. On the other hand, when data "1" that represents the presence of an edge is input, the weight coefficient k is set at 0 so that the input image data does not undergo emphasis conversion but is supplied as is, as the display image data, to liquid crystal panel 4.

[0058] As described above, also in this example, accelerative drive is turned off and the normal drive is effected for the pixels that have been determined to belong to image edges. Therefore, adverse effects from the accelerative drive such as unnatural hues, white spots, flickering and the like occurring at and around edges can be removed, whereby it is possible to realize high-quality image display. Further, the setup of making the weight coefficient k variable enables more flexible control of the image display data.

[0059] Next, a third comparative example of a liquid crystal display useful for understanding the invention will be described with reference to Figs. 13 through 16. The same components as those in the above first example are allotted with the same reference numerals and description for those is omitted. Here, Fig. 13 is a block diagram showing a schematic configuration of the liquid crystal display of the present example: Fig.14 is an illustrative view showing the non-conversion table content in ROM in the liquid crystal display of this example; Fig. 15 is a block diagram showing an edge detecting circuit in the liquid crystal display of this example; and Fig. 16 is an illustrative view showing another ROM configuration in the liquid crystal display of this example.

[0060] The liquid crystal display of the present example has ROM 31 (non-conversion table memory) that stores non-conversion parameters (i.e., the through-table shown in Fig . 14) in addition to ROM 3 (conversion table memory) that stores emphasis conversion parameters, as shown in Fig. 13, and selection control is made for every pixel between accelerative drive and normal drive, by selectively referring to either ROM 3 or ROM 31 based on the edge detection result from edge detecting circuit 70.

[0061] Here, edge detecting circuit 70 of this example is composed, as shown in Fig. 15, of 8 bit FF51 and FF52 for latching the input image data (8 bit data), a subtracter 53 for performing subtraction of data held at FF51 and FF52 to determine the differential value between neighboring pixels, a comparator 54 for comparing the differential value between neighboring pixels from subtracter 53 with comparative reference data, and in addition, a flip-flop (FF) 15 that produces 9 bit data by joining the comparison result (1 bit) from comparator 54 and the 8 bit pixel data from FF52 and outputs it.

[0062] For example, when 8 bit data "00···0011" is input from FF52 and data "1" that represents the presence of an edge is output from comparator 54, FF55 joins "1" and "00··· 0011" to generate 9 bit data "100···0011" and outputs it to emphasis converter 2. On the other hand, when data "0" that represents no edge is input, FF55 joins "0" and "00···0011" to generate 9 bit data "000···0011" and output it to emphasis converter 2.

[0063] Emphasis converter 2 checks the value at the ninth bit of the output data from FF55 to verify whether the current pixel data belongs to an edge. Then, the pixel of data tagged with the edge presence detection is subjected to the emphasis conversion with reference to ROM 3 (conversion table memory) , and the emphasis data is output to liquid crystal display panel 4. On the other hand, the pixel of data tagged with the non-edge detection is output straight through without conversion by making reference to ROM 31 (non-conversion table memory).

[0064] As described above, also in the liquid crystal display of this example, accelerative drive is turned off and the normal drive is effected for the pixel areas that have been determined to belong to image edges. Therefore, adverse effects from the accelerative drive such as unnatural hues, white spots, flickering and the like occurring at and around edges can be removed, whereby it is possible to realize high-quality image display.

[0065] In the above third example, the table contents of ROMs 3 and 31 may also be stored in a single table memory. Illustratively the non-conversion parameters and the emphasis conversion parameters are stored in respective table areas as shown in Fig. 16, and the table area to be referred to is selected based on the edge detection result, i.e. , the value at the ninth bit, whereby it is possible to produce the same effect as that when ROMs 3 and 31 are provided separately.

[0066] Next, a fourth comparative example useful for understanding the invention will be described in detail with reference to Figs.17 through 20. Fig.17 is a block diagram showing a schematic configuration of important components in a liquid crystal display of the present example; Fig. 18 is a schematic illustration showing the ROM table content in the liquid crystal display of the present example; Fig. 19 is a block diagram showing a noise detecting circuit in the liquid crystal display of the present example; and Fig.20 is a view for explaining the noise detecting circuit in the liquid crystal display of the present example.

[0067] Designated at 1 is a frame memory (FM), 3 a ROM storing emphasis conversion parameters depending on the gray scale level transitions of input image data, 2 an emphasis converter which, by comparing the current frame image data with the previous frame image data read out from FM2 and reading out emphasis conversion parameters corresponding to the comparison results (gray scale level transitions), determines and outputs the emphasis-converted data (corrected image data), and 5 a liquid crystal controller which, based on the emphasis-converted data from emphasis converter 2, outputs liquid crystal drive signals to a gate driver 6 and a source driver 7 of liquid crystal display panel 4.

[0068] Designated at 33 is a delay circuit for compensating the operation processing time of emphasis converter 2 in order to make the input image data in phase, with respect to the time axis, with the emphasis-converted data; 34 a noise detecting circuit for detecting noise laid over the input image data; 36 a selector for selecting either the current frame input image data or the emphasis-converted data from the emphasis converter 2, pixel by pixel, based on the noise detection result from noise detecting circuit 34, and outputting the selected data to liquid crystal controller 5.

[0069] In the above arrangement, ROM 3 stores a table in which emphasis conversion parameters corresponding to gray scale level transitions of the input image data from one frame to the next. When the number of display signal levels, i.e., the amount of display data, is 256 gray scales represented by 8 bits, emphasis conversion parameters for all 256x256 gray scale level transition patterns may be contained in ROM 3, but herein in order to reduce the memory capacity of ROM 3, a table storing only 9 × 9 emphasis conversion parameters (actually measured values) that represent nine representative gray scale levels every 32 gray scale levels as shown in Fig. 18 may be used.

[0070] Emphasis converter 2 reads out corresponding emphasis conversion parameters in accordance with the gray scale level transitions from one frame to the next by reference to ROM 3 and implements linear interpolation or other operations based on the emphasis conversion parameters so as to be able to determine the emphasis-converted data (corrected image data) for all the gray scale level transitions to be output to liquid crystal controller 5.

[0071] As described above, according to the present example, since selector 36 which is provided independently from the emphasis conversion processor is provided so as to select and output either the input image data or the emphasis-converted data, which are in phase with each other, it is possible, as will be described hereinbelow, to implement selection control between OS drive and normal drive based not only on the one-dimensional (with respect to the temporal axis) noise detection result as in the above-described conventional example but also on multi-dimensional noise detection result.

[0072] Specifically, in the present example, the noise detecting circuit 34 is composed of, as shown in Fig.19, a high-pass filter 9a for extracting high frequency components contained in the current frame input image data and a non-linear processor 9b for implementing non-linear processing on the high frequency components extracted by high-pass filter 9a, and performs noise detection based on the correlation between pixels of the input image data with respect to the horizontal direction and the vertical direction on the image frame.

[0073] Non-linear processor 9b regards any data having an amplitude level falling within the range between thresholds ±N as a noise component as shown in Fig. 20, and outputs "1" for the portion on which noise is superposed. In this way, two-dimensional spatial noise in the input image data can be detected, so that selector 36 can be controlled to select and output the current frame input image data for a pixel area where noise has been detected. Therefore, it is possible to positively reduce adverse effects from OS drive, such as white spots, flickering etc., generated by emphasis of unwanted noise components.

[0074] Here, the above noise detecting circuit 34 performs noise detection based on the correlation between pixels in the horizontal direction and in the vertical direction on the image frame, but the correlation between pixels is not limited to that between neighboring ones, and the correlation between pixels one or more pixels apart may also be used for noise detection. Further, various types of circuits can be adopted as a specific circuit configuration for detecting the spatial noise as above, and obviously the present example should not be limited to the circuit configuration described above.

[0075] For example, when the coded image data encoded based on a coding scheme that implements orthogonal transformation for every block made up of, for example, M×N pixels, is input/decoded to perform image display, block distortion whereby boundaries of processed blocks appear in the flat portion of the decoded image, and mosquito noise that causes haze around edges of characters and contours occur, depending on the compression ratio of the image coded data. It is obviously understood that provision of a circuit configuration for detecting these noises may prevent image degradation occurring due to enhancement of block distortion and mosquito noise.

[0076] Further, though in the above example the emphasis conversion processor is constituted of ROM 3 and emphasis converter 2, a two-dimensional function f(pre, cur) defined by, for instance, two variables, i.e., the gray scale level before transition and the gray scale level after transition, may be provided instead of ROM 3, so as to determine the emphasis-converted data for compensating the optical response characteristic of liquid crystal display panel 4.

[0077] Moreover, in the above example, the response speed of liquid crystal display panel 4 is improved by comparing the previous frame image data and the current flame image data and using the emphasis conversion parameters obtained based on the comparison. However, it is of course possible to provide a configuration in which the emphasis conversion parameters are determined based on image data two frames before or three frames before.

[0078] Next, a fifth comparative example useful for understanding the invention will be described in detail with reference to Fig.21. The same components as those in the above fourth example are allotted with the same reference numerals and description for those is omitted. Here, Fig.21 is a block diagram showing a noise detecting circuit in a liquid crystal display of the present example.

[0079] The arrangement of the liquid crystal display of this example is constructed such that, in the above-described fourth example described with reference to Fig. 17, the previous frame image data from FM2, as well as the current frame image data, is input to noise detecting circuit 34, and the noise detecting circuit 34, based on both pieces of image data, implements three-dimensional noise detection so as to perform switching control of selector 36 to thereby remove adverse effects from OS drive in a more reliable manner.

[0080] Specifically, noise detecting circuit 34 of this example includes: as shown in Fig.21, a high-pass filter 34a for detecting two-dimensional spatial noise; a non-linear processor 34b; a difference calculator 34c for detecting temporal noise; a comparator 34d; and an AND circuit 34e for producing the logical product of the spatial noise detection result and the temporal noise detection result.

[0081] Difference calculator 34c calculates the differential value in image data level between one frame and the next. Comparator 34d compares the differential value with the thresholds ±M. When the differential value falls between the thresholds ±M, the comparator outputs "1" regarding the data as noise. Thus, it is possible to detect noise based on the correlation of the input image data between pixels with respect to the temporal direction.

[0082] Also herein, it is obvious that temporal noise detection can be done based on the difference in image data level between frames one or more frame periods apart, not being limited to the two continuous frames. Further, various types of circuits can be adopted as a specific circuit configuration for detecting temporal noise.

[0083] AND circuit 34e outputs "1" only when the output signal from non-linear processor 9b and the output signal from comparator 9d are both "1", regarding the data as a noise component for the noise overlapping portion. With the above arrangement, it is possible to detect three-dimensional noise on the input image data. That is, selector 36 is controlled to switch so as to output the current frame input image data for the portions of pixels where noise has been detected, whereby it is possible to positively reduce adverse effects from OS drive, such as white spots, flickering etc. , generated by emphasis of unwanted noise components.

[0084] As described heretofore, according to the example , since selector (switching means) 10 which is provided independently from the emphasis converter is adapted to perform the switching between the input image data and the emphasis-converted data for the image data to be supplied to liquid crystal display panel 4, it is possible to perform two or greater dimensional noise detection and implement selection control between OS drive and normal drive in accordance with the noise detection result, regardless of the way the noise detection is done. Accordingly, it is possible to positively reduce adverse effects due to emphasis of unwanted noise components, hence prevent degradation of the displayed image.

[0085] In the above-described example , the thresholds for noise judgment ±N and ±M may be fixed values which are determined at the design stage or may be adapted to be variable so as to be set at arbitrary values in accordance with the user command input or various conditions such the source type of the input image data and other factors.

<The embodiment>

[0086] Fig. 22 is a block diagram showing the embodiment of a liquid crystal display according to the present invention.

[0087] The liquid crystal display of Fig.22 includes a frame memory (FM) 1, a write-gray scale level determining portion 120, a liquid crystal display panel 4, a liquid crystal controller 5, a characteristic quantity detector 150 and a controller 160.

[0088] First, characteristic quantity detector 150 detects a characteristic quantity of the input image data (Current data) . The characteristic quantity herein is defined as an index representing the cause of adverse effects (image degradation) such as white spots, flickering etc. , which occur when liquid crystal display panel 4 is driven using the emphasis-converted data determined for compensating the optical response characteristic (response speed) of liquid crystal display panel 4. The characteristic quantity is the quantity that is of high frequency components higher than a fixed value, indicating noise overlapped portions, edges of characters, contours etc.

[0089] If a picture area where this characteristic quantity is detected is just subjected to the normal OS drive process (emphasis process) in write-gray scale level determining portion 120, the noise component is enhanced and the image quality degrades. To avoid this, controller 160 controls write-gray scale level determining portion 120 so as to stop OS drive and output the input image data straight through.

[0090] Thus, the write-gray scale level data for liquid crystal display panel 4 is determined in such a manner that OS drive is adjusted to inhibit its strength for the areas where the characteristic quantity has been detected from the input image data while the normal OS drive is done for the other areas. Since liquid crystal display panel 4 is driven by liquid crystal controller 5 based on this write-gray scale level data, it is possible to realize high quality image display with correct reproduction of half gray scales while reducing adverse effects of OS drive due to noise etc. to as low as possible. It should be added that this OS drive control is implemented in display data units (for every pixel).

[Example 1]

[0091] Fig.23 is a block diagram showing example 1 of a liquid crystal display in this embodiment. In Fig.23, a characteristic quantity detector 150a is composed of a low-pass filter (LPF) 151, a subtracter 152 and a threshold portion 153. A write-gray scale level determining portion 120a is composed of an emphasis converter 121, an OS table memory 122 and a switch 123.

[0092] The input image data (Current Data) is input to characteristic quantity detector 150a, where low frequency components only are extracted by LPF 151. The low frequency components are subtracted from the input image data by subtracter 152 so as to obtain high frequency components. Then, high frequency components exceeding the predetermined threshold are extracted as the characteristic quantity of the input image, by threshold portion 153.

[0093] Emphasis converter 21 of write-gray scale level determining portion 120a compares the N-th frame input image data (Current Data) and the (N-1) - th frame image data (Previous Data) stored in frame memory 1 to determine the gray scale level transition patterns between both pieces of data. Then, based on the gray scale level transition patterns and the N-th frame input image data, the write-gray scale level determining portion determines the write-gray scale level data (emphasis-converted data) needed for image display of the N-th frame by reference to the emphasis conversion parameters stored in OS table memory 122.

[0094] Controller 160 controls switch 123 so that the input image data is directly sent to liquid crystal controller 5 for the portions of image data where a high frequency component exceeding the threshold has been detected by characteristic quantity detector 150a. For the portions of image data where no high frequency components exceeding the threshold has been detected, switch 123 is controlled so that the emphasis-converted data generated by emphasis converter 121 is sent to liquid crystal controller 5.

[0095] In this way, for a portion of the input image data in which a high frequency component exceeding the threshold has been detected, liquid crystal display panel 4 is driven by the input image data that is directly output without being processed through emphasis conversion to liquid crystal controller 5, whereby it is possible to realize high quality image display by reducing the adverse effects from OS drive such as white spots, flickering, etc. , due to excessive noise enhancement or the like, to as low as possible.

[0096] Also, for a portion of the input image data in which no high frequency component exceeding the threshold has been detected, the normal OS drive is implemented by outputting the emphasis-converted data generated from the input image data to liquid crystal controller 5 as the write-gray scale level data, whereby it is possible to display correct half gray scales by compensating the optical response characteristic (speed) of liquid crystal display panel 4.

[Comparative Example]

[0097] Fig.24 is a block diagram showing a comparative example of a liquid crystal display useful for understanding the embodiment of the present invention. This liquid crystal display has almost the same configuration as that in Fig. 23, except write-gray scale level determining portion 120b and characteristic quantity detector 150b. Here, the same components as those in Fig. 23 are allotted with the same reference numerals and description for those is omitted.

[0098] The write-gray scale level determining portion 120b of this example has a multiplier 124 for multiplying the emphasis-converted data calculated by emphasis converter 121 by a coefficient k ($0<k<1$), instead of the switch 123 in Fig. 23. The value of coefficient k used in this multiplier 124 is variably controlled by controller 160, so that the emphasis-converted data determined by emphasis converter 121 can be cut down by a predetermined amount and sent out to liquid crystal controller 5.

[0099] Characteristic quantity detector 150b is composed of a high-pass filter (HPF) 154 and a threshold portion 153. HPF 154 has both the function of the LPF151 and subtracter 152 in Fig. 23 and extracts high frequency components contained in the input image data.

[0100] Controller 160 controls the coefficient k in a variable manner such that k is set at a small value for the portions of the input image data where a high frequency component exceeding the threshold has been detected by characteristic quantity detector 150b while k is set at "1" for the portions of the input image data where no high frequency component exceeding the threshold has been detected.

[0101] In multiplier 124, the emphasis-converted data output from emphasis converter 121 is multiplied by the coefficient k which has been adjusted in accordance with the high frequency components contained in the input image data, and the result is output as the write-gray scale level data to liquid crystal controller 5. Therefore, the picture portions in which high frequency components have been detected can be reduced in emphasis-converted data level, so that it is possible to realize high quality image display by reducing adverse effects such as white spots, flickering and the like due to excessive enhancement of noise etc.

[0102] Here, controller 160 varies the value of coefficient k stepwise in accordance with the amount (level) of the high frequency components detected by characteristic quantity detector 150b. That is, since the greater the amount of high frequency components (for example, the higher the level of noise) the more the image quality degrades because of excessive enhancement of the high frequency components, the value of coefficient k is set to be smaller so that the level of OS drive (write-gray scale level data) will be lowered.

[0103] In this way, since the level of OS drive is suppressed for the high frequency components such as noise and the like that would cause image degradation while the level of OS drive in other portions is normally output to liquid crystal controller 5 so as to drive liquid crystal display panel 4, it is possible to realize high quality image display with correct reproduction of half gray scales while reducing harmful effects from OS drive such as white spots, flickering and the like due to excessive enhancement of noise etc., to as low as possible.

[Example 3]

[0104] Fig.25 is a block diagram showing example 3 of a liquid crystal display in the embodiment of the present invention. This liquid crystal display differs from the above-described examples in write-gray scale level determining portion 2c. Here, the same components as those in Fig. 24 are allotted with the same reference numerals and description for those is omitted.

[0105] As shown in Fig.25 write-gray scale level determining portion 120c of this example includes: a subtracter 125 for subtracting the input image data from the emphasis-converted data calculated by emphasis converter 121; a multiplier 124 for multiplying the output signal from this subtracter 125 by coefficient k (0<k<1); and an adder 126 for adding the output signal from this multiplier 124 to the input image data and outputting the sum to liquid crystal controller 5.

[0106] A controller 160 controls the coefficient k in a variable manner such that k is set at "0" for the portions of the input image data where a high frequency component exceeding the threshold has been detected by characteristic quantity detector 150b while k is set at "1" for the portions of the input image data where no high frequency component exceeding the threshold has been detected.

[0107] Accordingly, since, for the portions of the input image data where a high frequency component exceeding the threshold has been detected, the input image data is not emphasis-converted (i.e. , the emphasis-converted data is cut down) and is output to liquid crystal controller 5 while, for the portions where no high frequency component exceeding the threshold has been detected, the normally emphasis-converted data is output to liquid crystal controller 5, it is possible to realize high quality image display with correct reproduction of half gray scales while reducing adverse effects from OS drive such as white spots, flickering and the like due to excessive enhancement of noise etc., to as low as possible.

[0108] Here, controller 160 is also able to vary the value of coefficient k stepwise in accordance with the amount (level) of the high frequency components detected by characteristic quantity detector 150b. That is, if the input image presents a poor S/N and contains a great amount of high frequency components (meaning that it contains a high level of noise), the image quality is degraded more by excessive enhancement of the high frequency components. Therefore, the value of coefficient k can be adjusted so that the level of OS drive (write-gray scale level data) will be lowered.

[Example 4]

[0109] Fig.26 is a block diagram showing example 4 of a liquid crystal display in the embodiment of the present invention. This liquid crystal display differs from the above-described examples in write-gray scale level determining portion 2d. Here, the same components as those in Fig. 23 are allotted with the same reference numerals and description for those is omitted.

[0110] An OS table memory (ROM) 122 holds plural OS table memories each holding a different set of conversion parameters, in accordance with the amount (level) of high frequency components detected by a characteristic quantity detector 150, or the S/N ratio of the input image. An emphasis converter 121, based on the amount (level) of the high frequency components detected by characteristic quantity detector 150, selects as appropriate one from the above OS table memories.

[0111] Here, to make the description simple, in the present embodiment three kinds of ROMs are provided as OS table memory (ROM) 122, namely, OS table memory 122a (see Fig. 27) holding high level emphasis conversion parameters, OS table memory 122b(see Fig.28) holding low level emphasis conversion parameters and non-conversion table memory 122c (see Fig. 29) holding non-conversion parameters. Emphasis converter 121 refers to one of OS table memories 122a to 122c based on the control signal from a controller 160 and determines the write-gray scale level data to be supplied to liquid crystal display panel 4.

[0112] Though, in those shown in Figs.26 to 29, the emphasis conversion parameters (actual measurements) are stored in a 9 × 9 matrix of representative gray scale level transition patterns every 32 gray scale levels when the number of display signal levels , i.e., the amount of display data is constituted of 8 bits or 256 gray scales, obviously the present invention should not be limited to this.

[0113] Further, though description will be made of the case where overshoot drive is implemented by selectively referring to one of three kinds of OS table memories, it goes without saying that four or more kinds of OS table memories (ROMs) may be provided.

[0114] To begin with, two thresholds (the first threshold < the second threshold) are set up as the standards based on which controller 160 selects the OS table memory in accordance with the amount (level) of high frequency components detected by characteristic quantity detector 150.

[0115] OS table memory 122a is selected when the amount (level) of high frequency components detected by characteristic quantity detector 150 is lower than the first threshold, in other words, when noise has not been detected and normal OS drive is implemented. OS table memory 122b is selected when the amount (level) of high frequency components detected by characteristic quantity detector 150 is higher than the first threshold and lower than the second threshold, in other words , when some noise has been detected and the level of OS drive needs to be suppressed. OS table memory 122c is selected when the amount (level) of high frequency components detected by characteristic quantity detector 150 is higher than the second threshold, in other words, when much noise has been detected and no OS drive is implemented.

[0116] That is, controller 160 compares the amount (level) of high frequency components detected by characteristic quantity detector 150 to the first and second thresholds so as to determine the level the detected value falls in, and sends out to emphasis converter 121 a control signal that selects ROM 122a if this level is lower the first threshold, ROM 122b if the level is between the first and second thresholds and ROM 122c if the level is above the second threshold. Emphasis converter 121 determines the write-gray scale level data to be supplied to liquid crystal display panel 4 by referring to one of OS table memories 122a to 122c, based on the control signal from controller 160.

[0117] Thus, liquid crystal display panel 4 is driven based on the selection from OS table memories 122a to 122c, that is, by controlling the level of OS drive to be supplied to liquid crystal controller 5 in such a manner that the level of OS drive is cut down for the portions of high frequency components where the image quality would lower due to noise etc., and no OS drive is effected for the portions of high frequency components where the image quality would markedly lower due to noise etc., while normal level of OS drive is effected for the other portions. Therefore, it is possible to realize high quality image display with correct reproduction of half gray scales while reducing adverse effects from OS drive such as white spots, flickering and the like due to excessive enhancement of noise etc., to as low as possible.

[0118] Here, the tables in the OS table memories (ROMs) 122a to 122c may be stored in a single memory. Illustratively, the high level emphasis conversion parameters, the low level emphasis conversion parameters and the non-conversion parameters may be stored in respective table areas (LEVEL0 to LEVEL2), as shown in Fig. 30, and based on the amount (level) of high frequency components detected by characteristic quantity detector 150, reference may be selectively switched between the reference table areas (LEVEL0 and LEVEL1) in which the emphasis conversion parameters are stored and the table area (LEVEL2) for the non-conversion parameters.

[0119] In sum, the necessary parameter can be selectively read out from the emphasis conversion parameters and non-conversion parameters, by selecting one of the table areas (LEVEL0 to LEVEL2) to be referred to based on the control signal from controller 160 and referring to the address in each table area (LEVEL0 to LEVEL2), in accordance with the gray scale level transition from one frame to the next.

[0120] In this way, it is possible to obtain the same effect as that when OS table memories (ROMs) 122a to 122c are used.

[Example 5]

[0121] Fig.31 is a block diagram showing example 5 of a liquid crystal display in the embodiment of the present invention. This liquid crystal display has the same configuration as that shown in Fig.24, further including a video processor 7 for making various video adjustments for the input image signal; a system controller 128; and a remote controller (R/C) 129. Here, the same components as those in Fig. 24 are allotted with the same reference numerals and description for those is omitted.

[0122] The user is able to command a video adjustment such as contour enhancement correction and the like by R/C 129. System controller 128, based on the video adjustment command from the user, gives the order of the video adjustment for the input image data to video processor 127. For example, in accordance with the user's command for contour enhancement correction, video processor 127 extracts contours from the input image data and performs the enhancement process.

[0123] At the same time, system controller 128 sends out the content of the video adjustment command from the user to a threshold portion 153 and controller 160.

Based on the command content, threshold portion 153 controls or varies the thresholds for detecting the characteristic quantity that represents the possible occurrence of image degradation due to OS drive.

[0124] In this way the threshold of threshold portion 153 can be varied in accordance with the content of the video adjustment command from the user, so that it is possible to detect the suitable characteristic quantity in conformity with the video adjustment commanded by the user. For example, when the user gave a command of contour enhancement correction, it is possible to realize high quality image display by preventing occurrence of adverse effects due to OS drive such as white spots, flickering and the like around the contour enhanced areas.

[0125] The video adjustment herein should not be limited to contour enhancement correction. It is obvious that reduction control of the level of OS drive or stopping OS drive (to directly output the input image data) is effective in order to remove the adverse effects from OS drive, which are entailed with the adjustment as to the video frequency characteristic or gray scale level characteristic (dynamic range)

[Comparative Example]

[0126] Fig.32 is a block diagram showing a comparative example of a liquid crystal display useful for understanding the embodiment of the present invention. This liquid crystal display has the same configuration as that shown in Fig.24, further including a video decoder 130 for decoding image encoded data and a system controller 128. Here, the same components as those in Fig.24 are allotted with the same reference numerals and description for those is omitted.

[0127] In video decoder 130 the input image encoded data is decoded and the encoding parameters (quantization step size, bit rate etc.) contained in the image encoded data are extracted and transferred to system controller 128. System controller 128, in accordance with the encoding parameters, controls and varies the thresholds of threshold portion 153, so as to be able to positively detect encoding noise (block noise, mosquito noise).

[0128] Illustratively, since block noise and mosquito noise are liable to take place when, for example, the quantization step size for image encoded data is large, the thresholds at threshold portion 153 are set to be smaller so as to reliably detect these noises. For the portions where occurrence of block noise or mosquito noise is detected, the level of OS drive is lowered or OS drive is stopped so as to inhibit excessive emphasis of these noises, whereby it is possible to output suitable write-gray scale level data to liquid crystal controller 5.

[0129] Thus , it is possible to realize high quality image display by inhibiting adverse effects in OS drive due to block noise and mosquito noise while achieving compensation of OS drive for the optical response characteristic (response speed) of liquid crystal display panel 4.

[0130] In the present example, it is possible to provide a configuration in which the thresholds at threshold portion 153 can be controlled to vary by making use of the information as to the transfer (bandwidth) characteristics of the post-filter used in video decoder 130 in addition to the aforementioned encoding parameters.

[Comparative Example]

[0131] Fig.33 is a block diagram showing a comparative example of a liquid crystal display useful for understanding the embodiment of the present invention. This liquid crystal display, on the basis of the configuration of the previous comparative example described above with reference to Fig.32, includes as a characteristic quantity detector 150c, a block noise detector for detecting block distortion which will appear in flat areas of the decoded image when the image coded data which in particular has been compression coded by MPEG or the like is input and decoded to implement image display.

[0132] Characteristic quantity detector 150c of this example is composed of, as shown in Fig. 33, a boundary pixel extracting portion 155 for extracting the pixel values of a predetermined number of pixels at the block boundaries based on the predetermined block pattern (the pattern of encoding units or M×N blocks into which the image frame is divided) which is determined by the encoding scheme, a difference detector 156 for detecting difference between the pixel values that are extracted by the boundary pixel extracting portion 155, and a comparator 57 for comparing the differential data detected by the difference detector 156 with a predetermined threshold.

[0133] Specifically, when the differential data between plural pixels at the block boundary is greater than the threshold, a comparator 157 determines that the block noise is taking place and notifies a controller 160 of this fact. Controller 160 controls a write-gray scale level determining portion 120b for the input image data areas where block noise has been detected by characteristic quantity detector 150c so that it outputs the input image data to liquid crystal controller 5 instead of the emphasis-converted data, or it outputs the reduced level of the emphasis-converted data to liquid crystal controller 5. Thereby it is possible to realize high quality image display preventing occurrence of image degradation due to excessive enhancement of block noise.

[0134] Here, in the present example, and also similarly to the previous comparative example, the threshold used at comparator 157 is adapted to be arbitrary variable in accordance with the encoding parameters such as the quantization step size of the image encoded data, whereby it is possible to detect block noise occurring in the decoded image in a more reliable manner. It is also possible to provide a configuration in which the threshold at a threshold portion 153 can be controlled to vary by making use of the information as to the transfer (bandwidth) characteristics of the post-filter used in a video decoder

130.

[0135] It should be noted that the present invention is not limited by the above embodiment and various modifications can be added . For example, it is possible to provide a configuration in which various factors that cause adverse effects from OS drive are detected as the characteristic quantities of the input image data. Obviously it is possible to provide a configuration in which OS drive is controlled by an appropriate combination of the above-described examples.

[0136] Next, a seventh comparative example useful for understanding the invention will be described in detail with reference to Figs. 34 to 39. The same components as those in Fig. 1 are allotted with the same reference numerals and description for those is omitted. Here, Fig. 34 is a block diagram showing a schematic configuration of a liquid crystal display of the present example; Fig.35 is a schematic illustration showing the table content of an OS table memory for use in the liquid crystal display of this example; and Fig. 36 is a schematic illustrative view showing the optical response characteristic of a liquid crystal display panel for use in the liquid crystal display of this example.

[0137] Fig.37 is a block diagram showing one example of a video processor (contour enhancement correction circuit) in the liquid crystal display of this example; Fig. 38 is an illustrative chart showing another example of a video processor (gray scale level correction characteristic) in the liquid crystal display of this example ; and Fig. 39 is an illustrative chart showing still another example of a video processor (gray scale level correction characteristic) in the liquid crystal display of this example.

[0138] As shown in Fig.34, the liquid crystal display of the present example includes: an A/D converter 211 for converting the input image data into digital signals ; a video processor 212 for subjecting the A/D converted input image data to predetermined video adjustment processes; a remote control photo-sensor 213 for receiving a command signal input by the user through an unillustrated remote control transmitter (remote controller); and a control CPU 214 for controlling each processor by analyzing the command signal received by remote control photo-sensor 213. That is, the user is able to create favorite image rendering by giving a command for a desired video adjustment by means of a remote controller so as to cause control CPU 214 to control video processor 212.

[0139] A write-gray scale level determining means includes: an emphasis converter 2 which receives the previous frame image data (Previous Data) stored in a frame memory 1 and the current frame input image data (Current Data), reads out corresponding emphasis conversion parameters from OS table memory (ROM) 3a based on the combination of the input data (gray scale level transitions) and determines the emphasis-converted data for the input image data of the current frame so as to compensate the optical response characteristic of liquid crystal display panel 4; and a selector switch 215 for achieving selective switching between the emphasis-converted data and the input image data in frame units, in accordance with the user's video adjustment command, and outputting the selected one as the display image data to liquid crystal display panel 4.

[0140] Here, though, as shown in Fig. 35, the emphasis conversion parameters (actual measurements) are stored in a 9 × 9 matrix of representative gray scale level transition patterns every 32 gray scale levels when the number of display signal levels, i.e., the amount of display data is constituted of 8 bits or 256 gray scales, obviously the present invention should not be limited to this.

[0141] For simplicity, description hereinbelow will be described on the assumption that the liquid crystal display panel 4 used in this example is one that operates in the normally black mode having such an optical response characteristic that a transition from black or a low gray scale level to an intermediate gray scale level, in particular, takes a longer time, as shown in Fig .36. However, it is obvious that the present example can be applied to liquid crystal display panels of various optical response characteristics, not being limited to the aforementioned characteristic.

[0142] Next, specific examples of video processor 212 in this example and the OS drive control scheme in each example will be described in detail.

(1) Contour enhancement correction circuit

[0143] This circuit is to emphasize contours in the reproduced picture so as to increase sharpness by adding preshoot and overshoot at leading and trailing edges of the image signal, and is composed of, as shown in Fig. 37 for example, a contour signal generating circuit 216 for generating a contour signal at an edge, a gain control circuit 217 for controlling the strength of contour enhancement by adjustment of the amplitude of the contour signal, and an adder 218 for adding the contour signal adjusted as to the amplitude to the original image signal.

[0144] Here , receiving a video adjustment command from the user, control CPU 214 outputs a control signal to gain control circuit 217 which controls the amplitude of the contour signal, whereby the strength of contour enhancement can be adjusted by varying the amount of preshoot and the amount of overshoot to be added to the edge. In other words, the user is able to adjust the frequency characteristics of the input image data by video adjustment and implement favorite contour enhancement correction to obtain a sharp and clear displayed image.

[0145] When the user adjusts the strength of contour enhancement so as to increase the amount of preshoot and the amount of overshoot to be added to edges, these preshoot and overshoot areas (contour enhanced areas) are further excessively emphasized by emphasis converter 2, thus produces whitened spots of pixels, unnatural hues, flickering and the like, causing image degradation of the displayed image.

[0146] To deal with this, in the present example, when a command of contour enhancement exceeding a predetermined level is given from the user , control CPU 214 detects this and controls a selector switch 215 so that the input image data will be output straight through as the display image data to liquid crystal display panel 4. That is, selector switch 215 is controlled to switch in accordance with the content of the command for contour enhancement correction given by the user, whereby either the emphasis-converted data from emphasis converter 2 or the input image data is selectively supplied as the display image data to liquid crystal display panel 4.

[0147] As described above, when the user gives a command for increasing the strength of contour enhancement, OS drive is turned off (stopped) in response with this so that the input image data is directly output as the display image data to liquid crystal display panel 4. Thereby, it is possible to realize high quality image display by inhibiting occurrence of whitened spots of pixels, unnatural hues, flickering and the like, due to excessive emphasis of contour enhanced areas.

(2) Black extension correcting circuit

[0148] This function is to extend the low gray scale level side of the image signal to improve the gray scale level reproducibility on the low gray scale level side, and is achieved by providing a selectively controllable processor, LUT table (ROM) or the like having an input/output characteristic (gray scale level conversion characteristic) shown in Fig.38. This black extension correction can also be activated when the user selects the "movie mode" in the menu setup frame.

[0149] Here, when the user selects execution of black extension correction by video adjustment so as to adjust the displayed image to improve gray scale level reproducibility on the low gray scale level side (by selecting the characteristic indicated by the solid line in Fig.38), more pixels of the input image data fall on black or the low gray scale level side. This means that a larger number of gray scale level transition patterns which slow down the liquid crystal response speed take place. Illustratively, most of the gray scale level transitions will possibly occur within the hatching range shown in Fig.36. As a result, little improvement of the liquid crystal response speed can be obtained even if OS drive (emphasis conversion process) is implemented, while, conversely, emphasis converter 2 determines the emphasis-converted data on the basis that the previous frame has reached the target gray scale level despite the fact the gray scale level has not yet been reached. Consequently, gray scale levels which are deviated from the correct gray scale levels to be displayed are reproduced, and if such gray scale level transitions repeatedly occur, the displayed image will degrade due to occurrence of whitened and/or blackened pixels.

[0150] To deal with this, in the present example, when a command of black extension correction exceeding a predetermined level is given from the user, control CPU 214 detects this and controls a selector switch 215 so that the input image data will be directly output as the display image data to liquid crystal display panel 4. That is, selector switch 215 is controlled to switch in accordance with the content of the command for black extension correction (selection of video source) from the user, whereby either the emphasis-converted data from emphasis converter 2 or the input image data is selected and supplied as the display image data to liquid crystal display panel 4.

[0151] As described above, when the user gives a command for black extension correction, OS drive is turned off (stopped) in response to this so that the input image data is directly output as the display image data to liquid crystal display panel 4. Thereby, it is possible to realize high quality image display by inhibiting occurrence of whitened or blackened pixels and the like, which would arise when gray scale level transition patterns that slow down liquid crystal display panel 4 in response speed repeatedly appear as a result of black extension correction.

[0152] In connection with above, when a command for white extension correction is given, the possibility of repeated appearance of gray scale level transition patterns that slow down liquid crystal display panel 4 in response speed is reduced. Therefore, in this case it is obvious that the display image data to be supplied to liquid crystal display panel 4 should be the emphasis-converted data that has been emphasis-converted by emphasis converter 2 with OS drive activated.

(3) Black level correction circuit

[0153] This function is to adjust the brightness of the displayed image by correcting the black level of the image signal, and is achieved by providing a selectively controllable processor, LUT table (ROM), or the like, having an input/output characteristic (gray scale level conversion characteristic) shown in Fig.39, for example. This black level correction is the same as the typical "brightness adjustment" which can be adjusted in the menu setup frame by the user.

[0154] Here, when the user selects execution of black level correction by video adjustment so as to make the displayed image dark overall (by selecting the characteristic shown by the chain line in Fig. 39), more pixels of the input image data fall on black or the low gray scale level side. This means that a greater number of gray scale level transition patterns which slow down the liquid crystal response speed take place. Illustratively, most of the gray scale level transitions will possibly occur within the hatching range shown in Fig. 36. As a result, little improvement of the liquid crystal response speed can be obtained even if OS drive (emphasis conversion process) is implemented, while, conversely, emphasis converter 2 determines the emphasis-converted data on the basis that the previous frame has reached the target gray scale level despite the fact the gray scale level has not yet been reached. Consequently, gray scale levels which are deviated from the correct gray scale levels to be displayed are reproduced, and if such gray scale level transitions repeatedly occur, the displayed image will degrade due to occurrence of whitened and/or blackened pixels.

[0155] To deal with this, in the present example, when a command of black level correction exceeding a predetermined level is given from the user, control CPU 214 detects this and controls a selector switch 215 so that the input image data will be directly output as the display image data to liquid crystal display panel 4. That is, selector switch 215 is controlled to switch in accordance with the content of the command for black level correction (brightness adjustment) from the user, whereby either the emphasis-converted data from emphasis converter 2 or the input image data is selected and supplied as the display image data to liquid crystal display panel 4.

[0156] As described above, when the user gives a command for black level correction, OS drive is turned off (stopped) in response to this so that the input image data is directly output as the display image data to liquid crystal display panel 4. Thereby, it is possible to realize high quality image display by inhibiting occurrence of whitened or blackened pixels and the like, which would arise when gray scale level transition patterns that slow down liquid crystal display panel 4 in response speed repeatedly appear as a result of black level correction.

[0157] In connection with above, when the displayed image is made bright overall (by selecting the characteristic indicated by the solid line in Fig.39) by black level correction (brightness adjustment), the possibility of repeated appearance of gray scale level transition patterns that slow down liquid crystal display panel 4 in response speed is reduced. Therefore, in this case it is obvious that the display image data to be supplied to liquid crystal display panel 4 should be the emphasis-converted data that has been emphasis-converted by emphasis converter 2 with OS drive activated.

[0158] As stated above, according to the liquid crystal display panel of the present example, the output as the display image data to be supplied to liquid crystal display panel 4 is selectively switched between the emphasis-converted data that has been emphasis-converted by emphasis converter 2 and the input image data, in accordance with the command content of video adjustment for the frequency characteristics or gray scale level characteristics of the input image data, designated by the user. Therefore, adverse effects due to overshoot drive resulting from the video adjustment can be cancelled, whereby it is possible to reduce image degradation of the displayed image.

[0159] Though in the above seventh example the write-gray scale level determining means is constituted of emphasis converter 2 and OS table memory (ROM) 3a, a two-dimensional function f (pre, cur) defined by, for instance, two variables, i.e., the gray scale level before transition and the gray scale level after transition, may be provided instead of OS table memory 3a, so as to determine the emphasis-converted data for compensating the optical response characteristic of liquid crystal display panel 4.

[0160] Next, an eighth comparative example useful for understanding the invention will be described in detail with reference to Fig.40. The same components as those in the above seventh example are allotted with the same reference numerals and description for those is omitted. Here, Fig. 40 is a block diagram showing a schematic configuration of important components in a liquid crystal display of the present example.

[0161] As shown in Fig.40, the liquid crystal display of the present example has a write-gray scale level determining means comprised of an emphasis converter 2 for determining emphasis-converted data based on the emphasis conversion parameters read out from an OS table memory (ROM) 3a, a subtracter 221 for subtracting the input image data from the emphasis-converted data determined by the emphasis converter 2, a multiplier 222 for multiplying the output data from the subtracter 221 by a weight coefficient k ($0 \leq k \leq 1$) and an adder 223 for adding the output data from this multiplier 222 to the input image data to produce display image data.

[0162] Here, the value of weight coefficient k is variably controlled based on the control signal output from control CPU 14 in accordance with the content of the video adjustment command given by the user. That is, in response to the video adjustment command from the user, the display image data to be supplied to liquid crystal display panel 4 is variably controlled.

[0163] Specifically, in the normal setup usage mode, control CPU 214 controls so that the weight coefficient k of multiplier 222 is set at 1, whereby the emphasis-converted data for compensating the optical response characteristic of liquid crystal display panel 4 can be output as the display image data to liquid crystal display panel 4, while, when the user gives: (1) a command of contour enhancement correction in excess of a predetermined amount, (2) a command of black extension correction in excess of a predetermined amount, or (3) a command of black level correction in excess of a predetermined amount, control CPU 214 controls so that the weight coefficient $k = 0$, whereby the input image data can be directly output without being processed through emphasis conversion to liquid crystal display panel 4.

[0164] In the above way, according to the liquid crystal display panel of the present example, the output as the display image data to be supplied to liquid crystal display panel 4 is selectively switched between the emphasis-converted data and the input image data, in accordance with the command content of video adjustment for the frequency characteristics or gray scale level characteristics of the input image data, designated by the user. Therefore, adverse effects due to overshoot drive resulting from the video adjustment can be cancelled, whereby it is possible to reduce image degradation of the displayed image.

[0165] It should be noted that in the present example, the value of weight coefficient k ($0 \leq k \leq 1$) may be varied stepwise in accordance with the video adjustment command content designated by the user. Specifically, the weight coefficient k is controlled to be lessened from 1 to 0 as (1) the strength of contour enhancement correction becomes greater, (2) the amount of extension in black extension correction becomes greater or (3) the amount of reduction in back level in black level correction becomes greater, whereby the display image data to be supplied to liquid crystal display panel 4 can be varied stepwise, or in one word, the amount of OS drive can be reduced stepwise.

[0166] Thus, based on the video adjustment command content designated by the user, the emphasis-converted data for compensating the optical response characteristic of liquid crystal display panel 4 is variably controlled in a stepwise manner and supplied as the display image data to liquid crystal display panel 4, whereby it is possible to cancel adverse effects in overshoot drive resulting from the video adjustment, in a flexible manner, hence control the image degradation of the displayed image subtly.

[0167] Next, a ninth comparative example useful for understanding the invention will be described in detail with reference to Figs. 41 to 43. The same components as those in the above seventh example are allotted with the same reference numerals and description for those is omitted. Here, Fig. 41 is a block diagram showing a schematic configuration of a liquid crystal display of this example; Fig.42 is a schematic illustration showing the table content of a weak-conversion table memory for use in the liquid crystal display of this example; and Fig.43 is a schematic illustration showing the table content of a non-conversion table memory for use in the liquid crystal display of this example.

[0168] As shown in Fig.42 the liquid crystal display of the present example, in comparison with the above seventh example, includes: in addition to conversion table memory (ROM) 3a, a weak-conversion table memory (ROM) 3b storing weak-conversion parameters and a non-conversion table memory (ROM) 3c storing non-conversion parameters, with selector switch 215 omitted. Therefore, an emphasis converter 32 determines the display image data to be supplied to a liquid crystal display panel 4, referring to one of table memories (ROMs) 3a to 3c in accordance with the control signal from a control CPU 214.

[0169] Here, the write-gray scale level determining means is constructed of table memories (ROMs) 3a to 3c and emphasis converter 32 which determines the display image data to be output to liquid crystal display panel 4 by referring to the table memories (ROMs) 3a to 3c in a switchable manner based on the control signal from control CPU 214.

[0170] In the above configuration, weak-conversion table memory (ROM) 3b holds emphasis conversion parameters which are reduced in value compared to the emphasis conversion parameters stored in conversion table memory (ROM) 3a, as shown in Fig. 42. When this weak-conversion table memory 3b is selected to be referred to, the input image data is subjected to weak-emphasis conversion and output to liquid crystal display panel 4.

[0171] On the other hand, non-conversion table memory (ROM) 3c holds non-conversion parameters for directly outputting the input image data without conversion, as shown in Fig. 43. When this non-conversion table memory 3c is selected to be referred to, the input image data is adapted to be output straight through.

[0172] Specifically, in the normal setup usage mode, control CPU 214 makes control to select and refer to conversion table memory 3a, whereby the input image data is subjected to strong emphasis conversion which compensates the optical response characteristic of liquid crystal display panel 4 and the thus emphasis-converted data can be output as the display image data to liquid crystal display panel 4.

[0173] On the other hand, when the user gives: (1) a command of contour enhancement correction below a predetermined amount, (2) a command of black extension correction below a predetermined amount, or (3) a command of black level correction below a predetermined amount, control CPU 214 selects and refers to weak-conversion table memory 3b, whereby the input image data is subjected to weak emphasis conversion and the thus emphasis-converted data can be output as the display image data to liquid crystal display panel 4.

[0174] Further, when the user gives: (1) a command of contour enhancement correction in excess of a predetermined amount, (2) a command of black extension correction in excess of a predetermined amount, or (3) a command of black level correction in excess of a predetermined amount, control CPU 214 selects to refer to non-conversion table memory 3c, whereby the input image data can be directly output as the display image data, without being emphasis-converted, to liquid crystal display panel 4.

[0175] Thus, the display image data to be supplied to liquid crystal display panel 4 (the level of OS drive) is variably controlled stepwise, selecting a different table memory to refer to it based on the video adjustment command content designated by the user, whereby it is possible to cancel adverse effects in overshoot drive resulting from the video adjustment, in a flexible manner, hence control the image degradation of the displayed image subtly.

[0176] Here, to make the description simple, in the present example three kinds of table memories constituted of two kinds of conversion table memories 3a and 3b and a non-conversion memory 3c, are provided. However, the present example should not be limited thereto, and it is obvious that four or more table memories may be provided so that each table can be selected to be referred to in correspondence to a different video adjustment command content designated by the user.

[0177] Next, a tenth comparative example useful for understanding the invention will be described in detail with reference to Figs. 44 and 45. The same components as those in the above ninth example are allotted with the same reference numerals and description for those is omitted. Here, Fig. 44 is a block diagram showing a schematic configuration of a liquid crystal display of this example and Fig.45 is a schematic illustration showing the table content of a table memory for use in the liquid crystal display of this example.

[0178] As shown in Fig.44 the liquid crystal display of the present example has a single ROM 3d as a table memory for storing plural sets of emphasis conversion parameters and non-conversion parameters in respective reference table areas, and is configured so that an emphasis converter 42 determines the display image data to be supplied to a liquid crystal display panel 4 by reference to this ROM 3d.

[0179] Here, the write-gray scale level determining means is constructed of table memory (ROM) 3d and emphasis converter 42 which determines the display image data to be output to liquid crystal display panel 4 by referring to the reference table areas in this table memory (ROM) 3d in a switchable manner based on the control signal from control CPU 214.

[0180] This table memory (ROM) 3d, as shown in Fig. 45, stores emphasis conversion parameters for strong emphasis, emphasis conversion parameters for weak emphasis and non-conversion parameters, in respective table areas. These reference table areas are selectively switched for reference based on the control signal from control CPU 214.

[0181] Specifically, in the normal setup usage mode, the reference table area that stores the emphasis conversion parameters for strong emphasis is selected based on the control signal from control CPU 214, whereby the input image data is subjected to strong emphasis conversion which compensates the optical response characteristic of liquid crystal display panel 4 and the thus emphasis-converted data can be output as the display image data to liquid crystal display panel 4.

[0182] On the other hand, when the user gives: (1) a command of contour enhancement correction below a predetermined amount, (2) a command of black extension correction below a predetermined amount, or (3) a command of black level correction below a predetermined amount, control CPU 214 selects to refer to the reference table area that stores the emphasis conversion parameters for weak emphasis based on the control signal from control CPU 214, whereby the input image data is subjected to weak emphasis conversion and the thus emphasis-converted data can be output as the display image data to liquid crystal display panel 4.

[0183] Further, when the user gives: (1) a command of contour enhancement correction in excess of a predetermined amount, (2) a command of black extension correction in excess of a predetermined amount, or (3) a command of black level correction in excess of a predetermined amount, control CPU 214 selects to refer to the reference table area that stores the non-conversion parameters based on the control signal from control CPU 214, whereby the input image data can be directly output as the display image data, without being emphasis-converted, to liquid crystal display panel 4.

[0184] Thus, the display image data to be supplied to liquid crystal display panel 4 (the level of OS drive) is variably controlled stepwise, selecting a different reference table area to be referred to based on the video adjustment command content designated by the user, whereby it is possible to cancel adverse effects in overshoot drive resulting from the video adjustment, in a flexible manner, hence suppress the image degradation of the displayed image subtly.

[0185] Here, to make the description simple, the present example is described with reference to table memory 3d which has three kinds of reference table areas storing two sets of emphasis conversion parameters and non-conversion parameters. However, the present example should not be limited thereto, and it is obvious that four or more reference table areas may be provided so that each table area can be selected to be referred to in correspondence to a video adjustment command content designated by the user.

[0186] Additionally, though each example has been described taking a configuration that allows the user to make a command input of video adjustment through a remote controller, obviously, the user's command input can be made through a control panel portion provided for the device body.

[0187] Next, an eleventh comparative example useful for understanding the invention will be described in detail with reference to Figs. 46 to 48. The same components as those in Fig.1 are allotted with the same reference numerals and description for those is omitted. Here, Fig. 46 is a block diagram showing a schematic configuration of important components in a liquid crystal display of this example; Fig. 47 is a schematic illustration showing the table content of an OS table memory for use in the liquid crystal display of this example; and Fig.48 is a block diagram showing another configurational example of a write-gray scale level determining means in the liquid crystal display of this example.

[0188] In this example, as shown in Fig.46, a write-gray scale level determining means includes: an emphasis converter 22 which receives the previous frame image data (Previous Data) stored in a frame memory 1 and the current frame input image data (Current Data), reads out corresponding emphasis conversion parameters from OS table memory (ROM) 3 based on the combination of the input data (gray scale level transitions) and determines the emphasis-converted data for the input image data of the current frame so as to compensate the optical response characteristic of liquid crystal display panel 4; and a selector switch 19 for achieving selective switching between the emphasis-converted data and the input gray scale level data, in accordance with the user's command input and outputting the selected one as the write-gray scale level data to liquid crystal display panel 4.

[0189] Here, OS table memory (ROM) 300 is composed of OS table memories 300a and 300b that store different sets of conversion parameters corresponding to the temperature of liquid crystal display panel 4. There is also a control CPU 317 which makes appropriate selective switching between the OS table memories 300a and 300b based on the temperature of liquid crystal display panel 4 detected by a temperature sensor 316.

[0190] Here, to make the description simple, the present example will be described taking an example in which two kinds of ROMs, one for an OS table memory 300a used for LEVEL0 when the detected temperature of temperature sensor 316 is lower than the predetermined threshold temperature and the other for an OS table memory 300b used for LEVEL1 when the detected temperature of temperature sensor 316 is higher than the predetermined threshold temperature, are provided as OS table memory (ROM) 300 as shown in Fig.47, and overshoot drive is implemented by selectively referring to either of them. However, it goes without saying that three or more kinds of ROMs that correspond to three or more predetermined temperature ranges may be used.

[0191] Further, though, in Fig.47, the emphasis conversion parameters (actual measurements) are stored in a 9 × 9 matrix of representative gray scale level transition patterns every 32 gray scale levels when the number of display signal levels, i.e., the amount of display data is constituted of 8 bits or 256 gray scales, obviously the present invention should not be limited to this. Moreover, instead of a single temperature sensor 316 for detecting the temperature of liquid crystal display panel 4, a plurality of temperature sensors may be arranged at different positions within the panel plane.

[0192] This example further includes a remote control photo-sensor 318 for receiving a command signal input by the user through an unillustrated remote controller. Control CPU 317 analyzes the command signal received by remote control photo-sensor 318 and controls each processor. The selector switch 319 which selects the write-gray scale level data to be supplied to liquid crystal display panel 4 by achieving selective switching between the emphasis-converted data that has been converted by the emphasis converter 322 to compensate the optical response characteristic of the liquid crystal display panel 4 and the input image data, is controlled to switch by control CPU 317, in accordance with the command data of "stop overshoot drive" designated by the user through the remote controller.

[0193] Illustratively, while overshoot drive is actuated in the normal usage mode, either OS table memory 300a or 300b is selected in accordance with the detected temperature obtained through temperature sensor 316, and the emphasis conversion parameters corresponding to the gray scale transitions from one frame to the next are read out with reference to the selected OS table memory 300a or 300b. These emphasis conversion parameters are subjected to linear interpolation or other operations so as to determine the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns, which is supplied to liquid crystal display panel 4.

[0194] When undesirable degradation of the displayed image such as occurrence of white spots, noise emphasis, shadow tailing etc. , takes place due to device failure, the installed state of the device or the properties of the input image, the user can input a "stop overshoot drive" command using the remote controller. This command signal is received by remote control photo-sensor 318, and control CPU 317 analyzes this and controls selector switch 319 to switch so that the input gray scale level data will be directly supplied to liquid crystal display panel 4.

[0195] Accordingly, if adverse effects entailed with overshoot drive occur due to device failure, the installed state of the device or the properties of the input image, it is possible for the user to avoid degradation of the displayed image, by canceling the adverse effects from overshoot drive.

[0196] Though in the above eleventh example the write-gray scale level determining means is constituted of emphasis converter 22 and OS table memory (ROM) 300, a two-dimensional function f(pre, cur) defined by, for instance, two variables, i.e., the gray scale level before transition and the gray scale level after transition, may be provided instead of OS table memory 300, so as to determine the write-gray scale level data for compensating the optical response characteristic of liquid crystal display panel 4.

[0197] Alternatively, the write-gray scale level determining means may be comprised of, for example as shown in Fig.48, emphasis converter 322 for determining emphasis-converted data based on the emphasis conversion parameters read out from OS table memory (ROM) 300 , subtracter 320 for subtracting the input gray scale level data from the emphasis-converted data determined by the emphasis converter 322, a multiplier 321 for multiplying the output signal from the subtracter 320 by a weight coefficient k and an adder 323 for adding the output signal from this multiplier 321 to the input image data to produce write-gray scale level data, and based on the control signal from control CPU 317, the value of the weight coefficient k can be controlled so as to vary, to thereby variably control the write-gray scale level data to be supplied to liquid crystal display panel 4.

[0198] In this case, in the normal usage mode (in the overshoot drive active mode) , control CPU 317 makes the control of varying the weight coefficient of multiplier 321 to $k=1 \pm \alpha$ in accordance with the detected temperature obtained from temperature sensor 316, whereby it is possible to implement suitable emphasis conversion of the input image data in accordance with the temperature of liquid crystal display panel 4. On the other hand, when the "stop overshoot drive" command is input by the user, control CPU 317 sets the weight coefficient at k=0, whereby the input gray scale level data can be directly supplied, without being emphasis-converted, to liquid crystal display panel 4.

[0199] Next, a twelfth comparative example useful for understanding the invention will be described in detail with reference to Figs.49 and 50. The same components as those in the above eleventh example are allotted with the same reference numerals and description for those is omitted. Here, Fig.49 is a block diagram showing a schematic configuration of important components in the liquid crystal display of this example; and Fig.50 is a schematic illustration showing the table content of a non-conversion table memory for use in the liquid crystal display of this example.

[0200] As shown in Fig.49 the liquid crystal display of the present example, in comparison with the above eleventh example, further has a non-conversion table memory (ROM) 300c storing non-conversion parameters in the write-gray scale level determining means with selector switch 19 omitted. Therefore, a write-gray scale level determining portion 32 determines the write-gray scale level data to be supplied to a liquid crystal display panel 4, referring to one of table memories (ROMs) 300a to 300c. Here, the write-gray scale level determining means is constructed of these table memories (ROMs) 300a to 300c and a write-gray scale level determining portion 332 for determining write-gray scale level data by selectively referring to table memories (ROMs) 300a to 300c in accordance with the control signal from a control CPU 317.

[0201] Non-conversion table memory (ROM) 300c holds non-conversion parameters for directly outputting the input gray scale level data without conversion, as shown in Fig. 50. When this non-conversion table memory 300c is selected, the input gray scale level data is adapted to be output straight through. OS table memories 300a and 300b and non-conversion table memory 300c are selectively switched to be referred to, in accordance with the user's command input.

[0202] Illustratively, in the normal usage mode (in the overshoot drive active mode), either OS table memory 300a or 300b is selected in accordance with the detected temperature obtained through temperature sensor 316, and the write-gray scale level determining portion 32 reads out the emphasis conversion parameters corresponding to the gray scale transitions from one frame to the next with reference to the selected OS table memory 300a or 300b. These emphasis conversion parameters are subjected to linear interpolation or other operations so as to determine the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns, which is supplied to liquid crystal display panel 4.

[0203] On the other hand, when undesirable degradation of the displayed image, such as occurrence of white spots, noise emphasis, shadow tailing etc., takes place due to device failure, the installed state of the device or the properties of the input image, the user can give an input of a "stop overshoot drive" command using the remote controller. This command signal is received by remote control photo-sensor 318, and control CPU 17 analyzes this and makes switching control from OS table memory 300a or 300b to non-conversion table memory 300c, so that write-gray scale level determining portion 332 reads out the non-conversion parameters from non-conversion table memory 300c, and outputs the input gray scale level data as it is (outputs it straight through), without being emphasis-converted, to liquid crystal display panel 4.

[0204] Accordingly, if adverse effects entailed with overshoot drive occur due to device failure, the installed state of the device or the properties of the input image, it is possible for the user to avoid degradation of the displayed image, by canceling the adverse effects from overshoot drive.

[0205] Next, a thirteenth comparative example useful for understanding the invention will be described in detail with reference to Figs.51 and 52. The same components as those in the above twelfth example are allotted with the same reference numerals and description for those is omitted. Here, Fig.51 is a block diagram showing a schematic configuration of important components in a liquid crystal display of this example, and Fig.52 is a schematic illustration showing the table content of a table memory for use in the liquid crystal display of this example.

[0206] As shown in Fig.51 the liquid crystal display of the present example has a single ROM 300d as table memory 300, and is configured so that a write-gray scale level determining portion 342 determines the write-gray scale level data to be supplied to a liquid crystal display panel 4 by reference to this ROM 300d. Here, the write-gray scale level determining means is constructed of table memory (ROM) 300d and write-gray scale level determining portion 342 for determining the write-gray scale level data by referring to the reference table areas in this table memory (ROM) 300d in a switchable manner based on the control signal from a control CPU 317.

[0207] This table memory (ROM) 300d, as shown in Fig.52. stores emphasis conversion parameters for low temperature, emphasis conversion parameters for high temperature and non-conversion parameters, in respective table areas (LEVEL0 to LEVEL2). The reference table areas (LEVEL0 and LEVEL1) holding the emphasis conversion parameters and the table area (LEVEL2) for non-conversion parameters are selectively switched for reference based on the user's command input.

[0208] Specifically, based on the control signal from control CPU 317, the table areas (LEVEL0 to LEVEL2) to be referred to, are variably switched while the emphasis conversion parameters and non-conversion parameters can be selectively switched and read out referring to the address in each table area, in accordance with the gray scale level transition from one frame to the next.

[0209] Accordingly, in the normal usage mode (in the overshoot drive active mode), one of the conversion table areas (LEVEL0 to LEVEL1) in table memory 300d is selected in accordance with the detected temperature through temperature sensor 316, and write-gray scale level determining portion 342 reads out the emphasis conversion parameters corresponding to the gray scale level transitions from one frame to the next, by referring to the selected correction table area (LEVEL0 or LEVEL1). These emphasis conversion parameters are subjected to linear interpolation or other operations so as to determine the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns, which is supplied to liquid crystal display panel 4.

[0210] When undesirable degradation of the displayed image such as occurrence of white spots, noise emphasis, shadow tailing etc., takes place due to device failure, the installed state of the device or the properties of the input image, the user can give an input of a "stop overshoot drive" command using the remote controller. This command signal is received by remote control photo-sensor 18, and control CPU 317 analyzes this and controls to select the non-conversion table area (LEVEL2) of table memory 300d, so that write-gray scale level determining portion 42 reads out the non-conversion parameters from the non-conversion table area (LEVEL2) and outputs the input gray scale level data as it is (outputs it straight through), without being emphasis-converted, to liquid crystal display panel 4.

[0211] As described above, if adverse effects entailed with overshoot drive occur due to device failure, the installed state of the device or the properties of the input image, it is possible for the user to avoid degradation of the displayed image, by canceling the adverse effects from overshoot drive.

[0212] Additionally, though each example has been described taking a configuration where user command input is made through a remote controller, obviously, the user's command input can be made through a control portion provided for the device body.

[0213] Next, a fourteenth comparative example useful for understanding the invention will be described in detail with reference to Figs.53 and 54. The same components as those in Fig. 1 are allotted with the same reference numerals and description for those is omitted. Here, Fig. 53 is a block diagram showing a schematic configuration of important components in a liquid crystal display of this example, and Fig.54 is a schematic illustration showing the table content of an OS table memory for use in the liquid crystal display of this example.

[0214] In this example, as shown in Fig.53, a write-gray scale level determining means includes: an emphasis converter 422 which receives the previous frame image data (Previous Data) stored in a frame memory 1 and the current frame input image data (Current Data), reads out corresponding emphasis conversion parameters from OS table memory (ROM) 430 based on the combination of the input data (gray scale level transitions) and determines the emphasis-converted data for the gray scale level data of the current frame so as to compensate the optical response characteristic of a liquid crystal display panel 4 ; and a selector switch 419 for achieving selective switching between the emphasis-converted data and the input gray scale level data, based on the mounted state of the device and outputting the selected one as the write-gray scale level data to liquid crystal display panel 4.

[0215] Here, OS table memory (ROM) 430 is composed of OS table memories 430a and 430b that store different sets of conversion parameters depending on the temperature of liquid crystal display panel 4. There is also a control CPU 417 which makes appropriate selective switching between the OS table memories 430a and 430b based on the temperature of liquid crystal display panel 4 detected by a temperature sensor 16.

[0216] Here, to make the description simple, the present example will be described taking an example in which two kinds of ROMs, one for OS table memory 430a used for LEVEL0 when the detected temperature of temperature sensor 416 is lower than the predetermined threshold temperature and the other for OS table memory 430b used for LEVEL1 when the detected temperature of temperature sensor 416 is higher than the predetermined threshold temperature, are provided as OS table memory (ROM) 430 as shown in Fig.54, and overshoot drive is implemented by selectively referring to either of them. However, it goes without saying that three or more kinds of ROMs that correspond to three or more predetermined temperature ranges may be used.

[0217] Further, though, in Fig.54, the emphasis conversion parameters (actual measurements) are stored in a 9x9 matrix of representative gray scale level transition patterns every 32 gray scale levels when the number of display signal levels, i.e. , amount of display data is constituted of 8 bits or 256 gray scales, obviously the present example should not be limited to this. Moreover, instead of a single temperature sensor 416 for detecting the temperature of liquid crystal display panel 4, a plurality of temperature sensors may be arranged at different positions within the panel plane.

[0218] There is also a means for detecting the mounted state of the device, which includes a vertical inversion sensor 418a for detecting vertical inverted state of liquid crystal display panel 4 and an in-plane rotation sensor 418b for detecting the in-plane rotated state of liquid crystal display panel 4. Control CPU 417 analyzes the detected signals from these sensors 418a and 418b and controls each processor.

[0219] Here, vertical inversion sensor 418a is to detect state change between the normal installed state (stand-mounted state) shown in Fig.9(a) and the vertically inverted state (ceiling suspended state) shown in Fig.9(b). In-plane rotation sensor 418b is to detect state change between the normal installed state (stand-mounted state) shown in Fig.9(a) and the 90 degree rotated state (the portrait orientation state) shown in Fig.9(c). These sensors 418a and 418b may be constituted by respective gravity switches, etc., or may use a common orientation sensor such as a gyrosensor etc.

[0220] Selector switch 419 for selecting the write-gray scale level data to be supplied to liquid crystal display panel 4 by switching between the emphasis-converted data that has been converted by the emphasis converter 422 for compensating the optical response characteristic of the liquid crystal display panel 4 and the input image data, is controlled by control CPU 417 based on the detection result of sensors 418a and 418b as to the device installed state.

[0221] Illustratively, when the device is used in the normal installed state (stand-mounted state), either OS table memory 430a or 430b is selected in accordance with the detected temperature obtained through temperature sensor 416, and the emphasis conversion parameters corresponding to the gray scale transitions from one frame to the next are read out with reference to the selected OS table memory 430a or 430b. These emphasis conversion parameters are subjected to linear interpolation or other operations so as to determine the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns, which is supplied to liquid crystal display panel 4.

[0222] When the installed state of the device is switched to the vertically inverted state (ceiling suspended state) or to the 90 degree rotated state (portrait orientation state), flow passage of heated air in the device housing varies, so that temperature sensor 416 cannot detect the correct temperature of liquid crystal display panel 4. As a result, it is no longer possible to read out correct emphasis conversion parameters and incorrect emphasis-converted data may be supplied to liquid crystal display panel 4, causing degradation in the displayed image such as occurrence of white spots, shadow tailing etc.

[0223] Accordingly, in the present example, when the device installed state has changed as such, the change is detected by vertical inversion sensor 418a or in-plane rotation sensor 418b and control CPU 417 makes control to change over selector switch 419, whereby the input gray scale level data is output as it is to liquid crystal display panel 4. In this way, when the device installed state has changed, overshoot drive is automatically stopped so as to cancel adverse effects due to overshoot drive, thus making it possible to avoid image degradation of the displayed image.

[0224] Though in the above fourteenth example the write-gray scale level determining means is constituted of emphasis converter 422 and OS table memory (ROM) 430, a two-dimensional function f(pre, cur) defined by, for instance, two variables, i.e., the gray scale level before transition and the gray scale level after transition, may be provided instead of OS table memory 430, so as to determine the write-gray scale level data for compensating the optical response characteristic of liquid crystal display panel 4.

[0225] Next, a fifteenth comparative example useful for understanding the invention will be described in detail with reference to Fig.55. The same components as those in the above fourteenth example are allotted with the same reference numerals and description for those is omitted. Here, Fig.55 is a block diagram showing a write-gray scale level determining means in a liquid crystal display of this example.

[0226] As shown in Fig.55, the liquid crystal display of the present example has a write-gray scale level determining means comprised of, for example, an emphasis converter 422 for determining emphasis-converted data based on the emphasis conversion parameters read out from an OS table memory (ROM) 430, a subtracter 420 for subtracting the input gray scale level data from the emphasis-converted data determined by the emphasis converter 422, a multiplier 421 for multiplying the output signal from the subtracter 420 by a weight coefficient k and an adder 423 for adding the output signal from this multiplier 421 to the input image data to produce write-gray scale level data, and based on the control signal from a control CPU 417, the value of the weight coefficient k can be controlled so as to vary, to thereby variably control the write-gray scale level data to be supplied to a liquid crystal display panel 4.

[0227] Illustratively, when the device is used in the normal installed state (stand-mounted state), control CPU 417 variably controls the weight coefficient of multiplier 421 so that $k=1 \pm \alpha$ in accordance with the detected temperature from temperature sensor 16, whereby it is possible to make suitable emphasis conversion of the input gray scale level data in conformity with the temperature of liquid crystal display panel 4.

[0228] Further, when the installed state of the device is switched to the vertically inverted state (ceiling suspended state), this change is detected by a vertical inversion sensor 418a and control CPU 417 sets the weight coefficient k at 0, whereby the input gray scale level data can be output as it is, without being emphasis-converted, to liquid crystal display panel 4.

[0229] Alternatively, when, in the vertically inverted state (ceiling suspended state) , it is known that temperature sensor 416 is affected by generation of heat from other elements and detects a temperature higher than the actual temperature of liquid crystal display panel 4, the weight coefficient may be variably controlled so that $k=1 \pm \alpha-\beta$, whereby it is possible to remove influence of heat from other elements and supply the correct write-gray scale level data in conformity with the actual temperature of liquid crystal display panel 4, to liquid crystal display panel 4.

[0230] When the installed state of the device is switched to the 90 degree rotated state (portrait orientation state), this change is detected by an in-plane rotation sensor 418b and control CPU 417 sets the weight coefficient k at 0, whereby the input gray scale level data can be output as it is, without being emphasis-converted, to liquid crystal display panel 4.

[0231] Alternatively, when, in the 90 degree rotated state (portrait orientation state), it is known that temperature sensor 416 is affected by generation of heat from other elements and detects a temperature higher than the actual temperature of liquid crystal display panel 4, the weight coefficient may be variably controlled so that k=1 ± α-β, whereby it is possible to remove influence of heat from other elements and supply the correct write-gray scale level data in conformity with the actual temperature of liquid crystal display panel 4, to liquid crystal display panel 4.

[0232] As stated above, when the installed state of the device has changed, the write-gray scale level data to be supplied to liquid crystal display panel 4 is produced so that the input gray scale level data is output as it is or the emphasis-converted data is output with its degree of emphasis varied so as to automatically cancel adverse effects from overshoot drive. Thus, it is possible to avoid image degradation of the displayed image.

[0233] Next, a sixteenth comparative example useful for understanding the invention will be described in detail with reference to Figs.56 and 57. The same components as those in the above fourteenth example are allotted with the same reference numerals and description for those is omitted. Here, Fig.56 is a block diagram showing a schematic configuration of important components in a liquid crystal display of this example, and Fig.57 is a schematic illustration showing the table content of a non-conversion table memory for use in the liquid crystal display of this example.

[0234] As shown in Fig.56 the liquid crystal display of the present example, in comparison with the above fourteenth example, further has a non-conversion table memory (ROM) 3c storing non-conversion parameters in the write-gray scale level determining means with selector switch 19 omitted. Therefore, a write-gray scale level determining portion 32 determines the write-gray scale level data to be supplied to a liquid crystal display panel 4, referring to one of table memories (ROMs) 430a to 430c. Here, the write-gray scale level determining means is constructed of these table memories (ROMs) 430a to 430c and a write-gray scale level determining portion 432 for determining write-gray scale level data by selectively referring to table memories (ROMs) 430a to 430c in accordance with the control signal from a control CPU 417.

[0235] Non-conversion table memory (ROM) 430c holds non-conversion parameters for directly outputting the input gray scale level data without conversion, as shown in Fig. 57. When this non-conversion table memory 430c is selected, the input gray scale level data is adapted to be output straight through. OS (conversion) table memories 430a and 430b and non-conversion table memory 430c are selectively switched to be referred to, in accordance with the installed state of the device.

[0236] Illustratively, when the device is used in the normal installed state (stand-mounted state) , either OS table memory 430a or 430b is selected in accordance with the detected temperature obtained through temperature sensor 416, and write-gray scale determining portion 432 reads out the emphasis conversion parameters corresponding to the gray scale transitions from one frame to the next referring to the selected OS table memory 430a or 430b. These emphasis conversion parameters are subjected to linear interpolation or other operations so as to determine the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns , which is supplied to liquid crystal display panel 4.

[0237] On the other hand, when the installed state of the device is switched to the vertically inverted state (ceiling suspended state) or to the 90 degree rotated state (portrait orientation state), flow passage of heated air in the device housing varies, so that temperature sensor 416 cannot detect the correct temperature of liquid crystal display panel 4. As a result, it is no longer possible to read out suitable emphasis conversion parameters and incorrect emphasis-converted data may be supplied to liquid crystal display panel 4, causing degradation in the displayed image such as occurrence of white spots, shadow tailing etc.

[0238] Accordingly, in the present example, when the device installed state has changed as such, the change can be detected by vertical inversion sensor 418a or in-plane rotation sensor 418b and control CPU 417 makes switching control from OS table memory 430a or 430b to non-conversion table memory 3c, so that write-gray scale level determining portion 432 reads out the non-conversion parameters from non-conversion table memory 430c, and outputs the input gray scale level data as it is (outputs it straight through), without being emphasis-converted, to liquid crystal display panel 4.

[0239] In this way, when the device installed state has changed, overshoot drive is automatically stopped so as to cancel adverse effects due to overshoot drive, thus making it possible to avoid image degradation of the displayed image due to occurrence of unwanted white spots, occurrence of shadow tailing or the like.

[0240] Next, a seventeenth comparative example useful for understanding the invention will be described in detail with reference to Fig.58. The same components as those in the above sixteenth example are allotted with the same reference numerals and description for those is omitted. Here, Fig. 58 is a block diagram showing a schematic configuration of important components in a liquid crystal display of this example.

[0241] As shown in Fig.58 the liquid crystal display of this example, instead of having a non-conversion table memory (ROM) 430c as in the above seventeenth example, has emphasis conversion table memories (ROMs) 430a and 430b for low and high temperatures to be referred to in the normally installed state (stand-mounted state), further including emphasis conversion table memories (ROMs) 430d and 430e for low and high temperatures to be referred to in the vertical inverted state (ceiling suspended state), and emphasis conversion table memories (ROMs) 430f and 430g for low and high temperatures to be referred to in the 90 degree rotated state (the portrait orientation state). Here, the write-gray scale level determining means is constructed of table memories (ROMs) 430a, 430b, 430d to 430g, and a write-gray scale level determining portion 442 for determining the write-gray scale level data by referring to table memories (ROMs) 430a, 430b, 430d to 430g in a switchable manner based on the control signal from a control CPU 417.

[0242] Illustratively, when the device is used in the normal installed state (stand-mounted state), either OS table memory 430a or 430b is selected in accordance with the detected temperature obtained through temperature sensor 416, and write-gray scale determining portion 42 reads out the emphasis conversion parameters corresponding to the gray scale transitions from one frame to the next referring to the selected OS table memory 430a or 430b. These emphasis conversion parameters are subjected to linear interpolation or other operations so as to determine the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns, which is supplied to liquid crystal display panel 4.

[0243] On the other hand, when the installed state of the device is switched to the vertically inverted state (ceiling suspended state), this change is detected by a vertical inversion sensor 418a and control CPU 417 makes switching control from OS table memories 430a and 430b to OS table memories 430d and 430e, whereby write-gray scale level determining portion 442 reads out the emphasis conversion parameters referring to emphasis conversion table memory 430d and 430e so as to determine the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns and supply it to liquid crystal display panel 4.

[0244] Also, when the installed state of the device is switched to the 90 degree rotated state (portrait orientation state), this change is detected by a in-plane rotation sensor 418b and control CPU 417 makes switching control from OS table memories 430a and 430b to OS table memories 430f and 430g, whereby write-gray scale level determining portion 442 reads out the emphasis conversion parameters referring to emphasis conversion table memories 430f and 430g so as to determine the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns and supply it to liquid crystal display panel 4.

[0245] In this way, a plurality of emphasis conversion table memories 430a, 430b, 430d to 430g which store different, most suited, different sets of emphasis conversion parameters for respective installed states are provided, so that the plurality of emphasis conversion table memories 430a, 430b and 430d to 430g are switched to be referred to in conformity with the installed state of the device, whereby the emphasis-converted data that is most suitably emphasis-converted for each set state can be output as the write-gray scale level data to liquid crystal display panel 4. Therefore, it is possible to automatically cancel adverse effects due to overshoot drive resulting from the installed state of the device, hence prevent image degradation of the displayed image.

[0246] Next, an eighteenth comparative example useful for understanding the invention will be described in detail with reference to Figs.59 and 60. The same components as those in the above sixteenth example are allotted with the same reference numerals and description for those is omitted. Here, Fig.59 is a block diagram showing a schematic configuration of important components in a liquid crystal display of this example, and Fig. 60 is a schematic illustration showing the table content of a table memory for use in the liquid crystal display of this example.

[0247] As shown in Fig.59 the liquid crystal display of the present example has a single ROM 430h as a table memory 430, and is configured so that a write-gray scale level determining portion 452 determines the write-gray scale level data to be supplied to a liquid crystal display panel 4 by reference to this ROM 430h. Here, the write-gray scale level determining means is constructed of table memory (ROM) 430h and write-gray scale level determining portion 452 for determining the write-gray scale level data by referring to the reference table areas in this table memory (ROM) 430h in a switchable manner based on the control signal from a control CPU 417.

[0248] This table memory (ROM) 430h, as shown in Fig. 60, stores emphasis conversion parameters for low temperature, emphasis conversion parameters for high temperature and non-conversion parameters, in respective table areas (LEVEL0 to LEVEL2). The reference table areas (LEVEL0 and LEVEL1) holding the emphasis conversion parameters and the table area (LEVEL2) for non-conversion parameters are selectively switched for reference based on the installed state of the device.

[0249] Specifically, based on the control signal from control CPU 417 in accordance with the outputs from a vertical inversion sensor 418a and in-plane rotation sensor 418b, the table areas (LEVEL0 to LEVEL2) to be referred to, are variably switched while the emphasis conversion parameters and non-conversion parameters can be selectively switched and read out referring to the corresponding address in each table area, in accordance with the gray scale level transition from one frame to the next.

[0250] Accordingly, in use at the normal installed usage state (stand-mounted state), one of the conversion table areas (LEVEL0 to LEVEL1) in table memory 3h is selected in accordance with the detected temperature through temperature sensor 416, and write-gray scale level determining portion 452 reads out the emphasis conversion parameters corresponding to the gray scale transitions from one frame to the next, by referring to the selected table area (LEVEL0 or LEVEL1). These emphasis conversion parameters are subjected to linear interpolation or other operations so as to determine the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns, which is supplied to liquid crystal display panel 4.

[0251] When the installed state of the device is switched to the vertically inverted state (ceiling suspended state) or to the 90 degree rotated state (portrait orientation state), this change is detected by vertical inversion sensor 418a or in-plane rotation sensor 418b, and control CPU 417 controls to select the non-conversion table area (LEVEL2) of table memory 430h, so that write-gray scale level determining portion 452 reads out the non-conversion parameters from the non-conversion table area (LEVEL2) and outputs the input gray scale level data as it is (outputs it straight through), without being emphasis-converted, to liquid crystal display panel 4.

[0252] In this way, when the device installed state has changed, overshoot drive is automatically stopped so as to cancel adverse effects due to overshoot drive, thus making it possible to avoid image degradation of the displayed image due to occurrence of unwanted white spots, occurrence of shadow tailing or the like.

[0253] Next, a nineteenth comparative example useful for understanding the invention will be described in detail with reference to Fig.61. The same components as those in the above eighteenth example are allotted with the same reference numerals and description for those is omitted. Here, Fig. 61 is a schematic illustration showing the table content of a table memory for use in a liquid crystal display of this example.

[0254] The liquid crystal display of this example is configured on the basis of that in the above eighteenth example, wherein in place of table memory (ROM) 430h having the non-conversion table area (LEVEL2), a table memory (ROM) 430i having a plurality of reference table areas (LEVEL0, LEVEL0-1 to 2, LEVEL1, LEVLE1-1 to 2) for storing the most suitable sets of emphasis conversion parameters for individual installed states are provided. Here, the write-gray scale level determining means is constructed of table memory (ROM) 430i and a write-gray scale level determining portion for determining the write-gray scale level data by referring to the reference table areas in this table memory (ROM) 430i in a switchable manner based on the control signal from a control CPU 417.

[0255] This table memory (ROM) 430i, as shown in Fig.61, stores emphasis conversion parameters for low temperature and for high temperature used in the normal installed state (stand-mounted state), emphasis conversion parameters for low temperature and for high temperature used in the vertically inverted state (ceiling suspended state), emphasis conversion parameters for low temperature and for high temperature used in the 640 degree rotated state (portrait orientation state), in respective table areas (LEVEL0, LEVEL1, LEVEL0-1, LEVEL1-1, LEVEL0-2, LEVLE1-2), and these reference table areas holding these sets of emphasis conversion parameters are selectively switched based on the installed state of the device.

[0256] Specifically, in use at the normal installed state (stand-mounted state), one of the conversion table areas (LEVEL0 and LEVEL1) in table memory 430i is selected in accordance with the detected temperature through temperature sensor 416, and the write-gray scale level determining portion reads out the emphasis conversion parameters corresponding to the gray scale transitions from one frame to the next, by referring to the selected table area (LEVEL0 or LEVEL1). These emphasis conversion parameters are subjected to linear interpolation or other operations so as to determine the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns, which is supplied to liquid crystal display panel 4.

[0257] When the installed state of the device is switched to the vertically inverted state (ceiling suspended state), this change is detected by vertical inversion sensor 418a, and control CPU 417 controls to select the conversion table areas (LEVEL0-1 and LEVEL1-1) of table memory 430i, so that the write-gray scale level determining portion reads out the emphasis conversion parameters referring to the conversion table areas (LEVEL0-1 and LEVEL1-1) and determines the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns and supplies it to liquid crystal display panel 4.

[0258] Further, when the installed state of the device is switched to the 90 degree rotated state (portrait orientation state), this change is detected by a in-plane rotation sensor 418b and control CPU 417 makes control to select the conversion table areas (LEVEL0-2 and LEVEL1-2) of table memory 430i, so that the write-gray scale level determining portion reads out the emphasis conversion parameters referring to the conversion table areas (LEVEL0-2 and LEVEL1-2) and determines the emphasis-converted data for the input gray scale level data for all the gray scale level transition patterns and supplies it to liquid crystal display panel 4.

[0259] In this way, the plurality of reference table areas LEVEL0, LEVEL0-1 to 2, LEVEL1, LEVLE1-1 to 2) which store different, most suited sets of emphasis conversion parameters for respective installed states are provided, so that these plural reference table areas are switched to be referred to in conformity with the installed state of the device, whereby the emphasis-converted data that is most suitably emphasis-converted for each installed state can be output as the write-gray scale level data to liquid crystal display panel 4. Therefore, it is possible to automatically cancel adverse effects due to overshoot drive resulting from the installed state of the device, hence prevent image degradation of the displayed image.

Industrial Applicability

[0260] The liquid crystal display according to the present invention is effective for the displayed image image for computers as well as television receivers. Particularly, it is suitable to further improve the displayed image in image quality in an overshoot drive configuration for enhancing the optical response characteristic of the liquid crystal display panel.

Claims

1. A liquid crystal display for image display using a liquid crystal display panel (4), comprising:

   an emphasis converter means (121) adapted to generate emphasis-converted data for input image data for compensating an optical characteristic of the liquid crystal display panel, in accordance with a gray scale level transition from a previous vertical period to a current vertical period;
   and
   a selecting means (123) adapted to select either the emphasis-converted data or the input image data, pixel by pixel and to supply the selected one as display image data to the liquid crystal display panel (4)
   characterized by further comprising
   a characteristic quantity detecting means (150, 150a, 150b, 150c) adapted to detect high frequency components with amplitude higher than a fixed value in the image, which indicate edge portions or noise contained in the input image data;
   wherein the selecting is based on a detection result of said characteristic quantity detecting means , and
   wherein the input image data is selected when a high frequency component with amplitude higher than the fixed value is detected.

Patentansprüche

1. Flüssigkristallanzeige für die Bildanzeige unter Verwendung einer Flüssigkristallanzeigetafel (4), mit:

   einem Gewichtungsumsetzungsmittel (121), das dafür ausgelegt ist, gewichtungsumgesetzte Daten für Eingangsbilddaten zu erzeugen, um eine optische Charakteristik der Flüssigkristallanzeigetafel in Übereinstimmung mit einem Graustufenpegelübergang von einer früheren Vertikalperiode zu einer momentanen Vertikalperiode zu kompensieren; und
   einem Auswahlmittel (123), das dafür ausgelegt ist, entweder die gewichtungsumgesetzten Daten oder die Eingangsbilddaten Pixel für Pixel zu wählen und die ausgewählten Daten als Anzeigebilddaten an die Flüssigkristallanzeigetafel (4) zu liefern,
   gekennzeichnet durch
   ein Mittel (150, 150a, 150b, 150c) zum Detektieren einer charakteristischen Größe, das dafür ausgelegt ist, in dem Bild Hochfrequenzkomponenten zu detektieren, die eine Amplitude besitzen, die größer als ein fester Wert ist, die Kantenabschnitte oder Rauschen, die in den Eingangsbilddaten enthalten sind, angeben;
   wobei das Auswählen auf einem Detektionsergebnis der Mittel zum Detektieren einer charakteristischen Größe beruht und
   wobei die Eingangsbilddaten gewählt werden, wenn eine Hochfrequenzkomponente detektiert werden, die eine Amplitude besitzen, die größer als der feste Wert ist.

Revendications

1. Affichage à cristaux liquides pour un affichage d'image à l'aide d'un panneau d'affichage à cristaux liquides (4), comprenant :

   des moyens convertisseurs d'accentuation (121) aptes à générer des données à accentuation convertie pour des données d'image d'entrée, afin de compenser une caractéristique optique du panneau d'affichage à cristaux liquides, selon une transition de niveau d'échelle de gris entre une période verticale précédente et une période verticale actuelle ; et
   des moyens de sélection (123) aptes à sélectionner soit les données à accentuation convertie, soit les données d'image d'entrée, pixel par pixel, et aptes à fournir l'image d'affichage sélectionnée, sous la forme de données d'image d'affichage, au panneau d'affichage à cristaux liquides (4),
   caractérisé en ce qu'il comprend par ailleurs des moyens de détection de quantité caractéristique (150, 150a, 150b, 150c) aptes à détecter des composants haute fréquence d'une amplitude supérieure à des parties de bordures à valeur fixée ou à un bruit contenu dans les données d'image d'entrée ;
   étant précisé que la sélection est basée sur un résultat de détection des moyens de détection de quantité caractéristique, et
   que les données d'image d'entrée sont sélectionnées quand un composant haute fréquence d'une amplitude supérieure à la valeur fixée est détecté.

FIG. 1

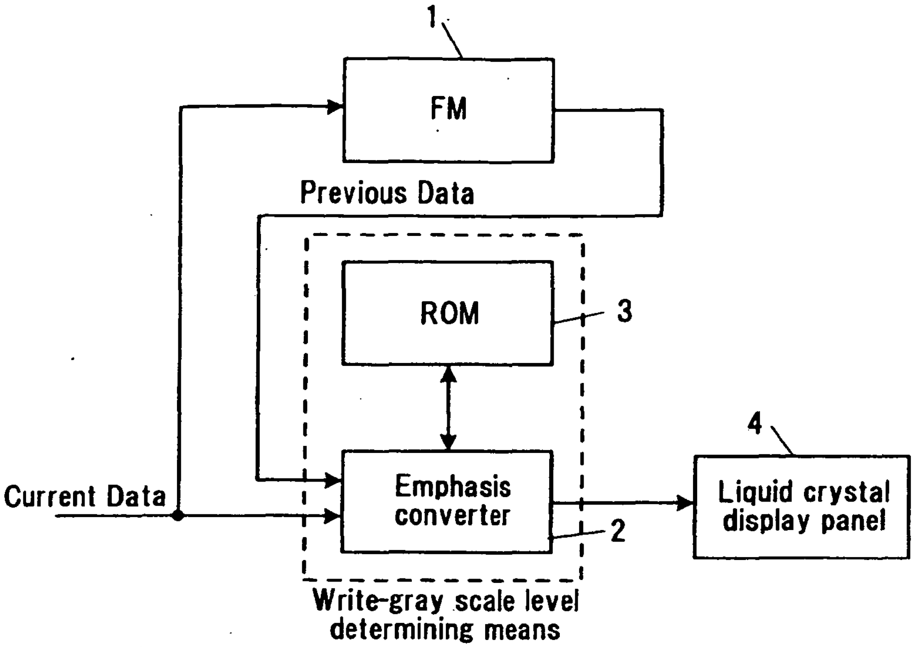


FIG. 2

		Address (current image data: 8 bit)														
		0	1	2	3	4	5				250	251	252	253	254	255
Address (previous image data: 8 bit)	0	0	2	4	6	8	9				252	253	254	255	255	255
	1	0	1	2	5	7						253	254	255	255	255
	2	0	0	2	4	6						253	254	255	255	255
	3	0	1	1	3	4						253	254	255	255	255
	4	0	2	3	3								254	255	255	255
	5	0														255
	250	0														255
	251	0	0	0	1							251	253	255	255	255
	252	0	0	0	1	2						250	252	255	255	255
	253	0	0	0	1	2						250	251	253	255	255
	254	0	0	0	1	2						249	250	252	254	255
	255	0	0	0	1	2	3				247	249	250	252	254	255

FIG. 3

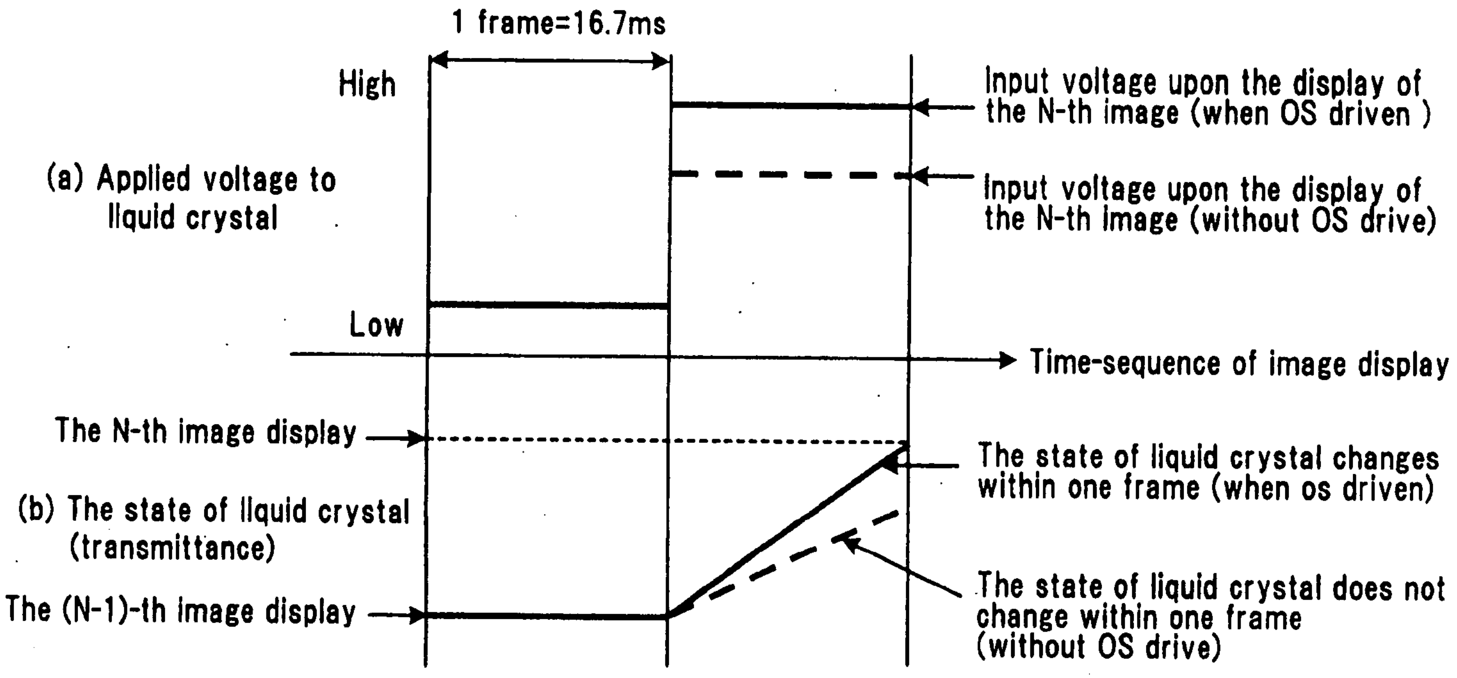

1 frame=16.7ms
High
(a) Applied voltage to liquid crystal
Low
Input voltage upon the display of the N-th image (when OS driven)
Input voltage upon the display of the N-th image (without OS drive)
Time-sequence of image display
The N-th image display
(b) The state of liquid crystal (transmittance)
The (N-1)-th image display
The state of liquid crystal changes within one frame (when os driven)
The state of liquid crystal does not change within one frame (without OS drive)

FIG. 4

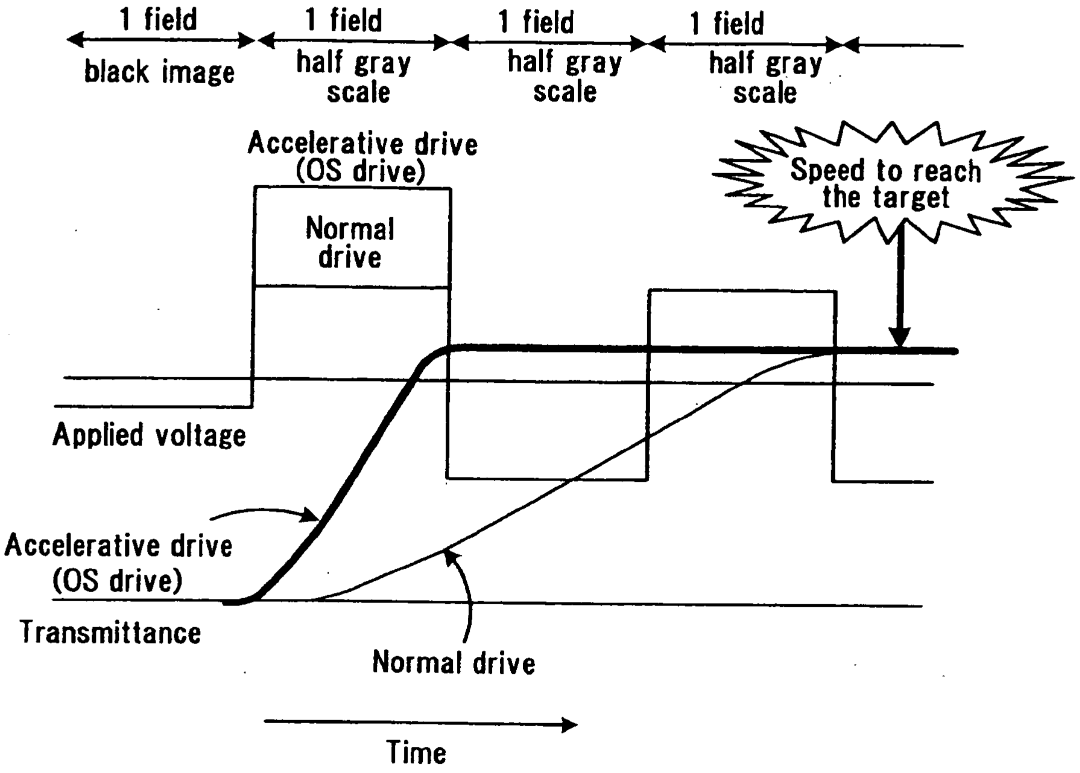

1 field
black image
1 field
half gray scale
1 field
half gray scale
1 field
half gray scale
Accelerative drive (OS drive)
Normal drive
Speed to reach the target
Applied voltage
Accelerative drive (OS drive)
Transmittance
Normal drive
Time

FIG. 5

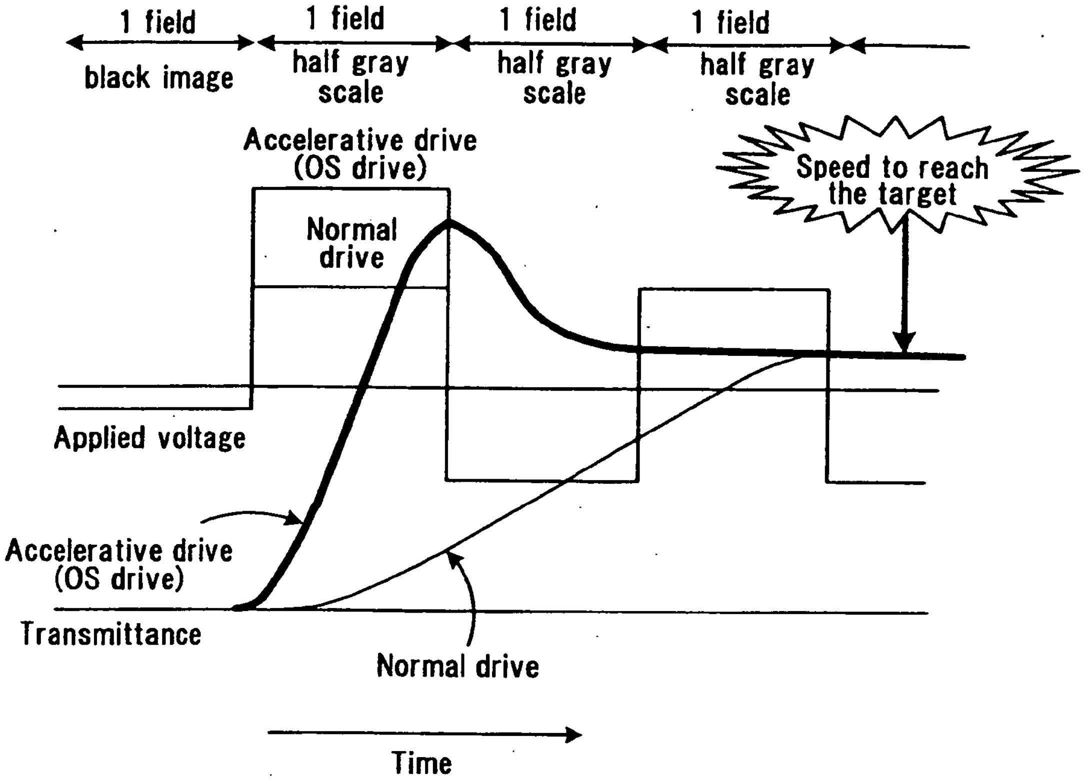
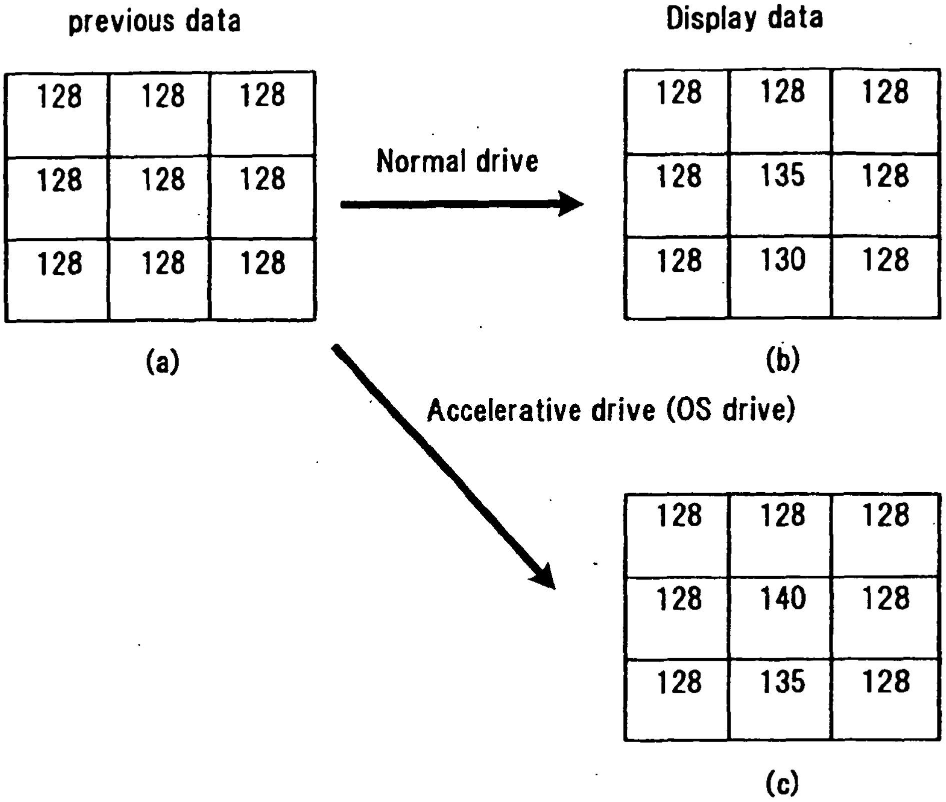

1 field
black image
1 field
half gray scale
1 field
half gray scale
1 field
half gray scale
Accelerative drive (OS drive)
Normal drive
Speed to reach the target
Applied voltage
Accelerative drive (OS drive)
Transmittance
Normal drive
Time

FIG. 6



(a) previous data

128	128	128
128	128	128
128	128	128

(b) Display data

128	128	128
128	135	128
128	130	128

(c)

128	128	128
128	140	128
128	135	128

FIG. 7

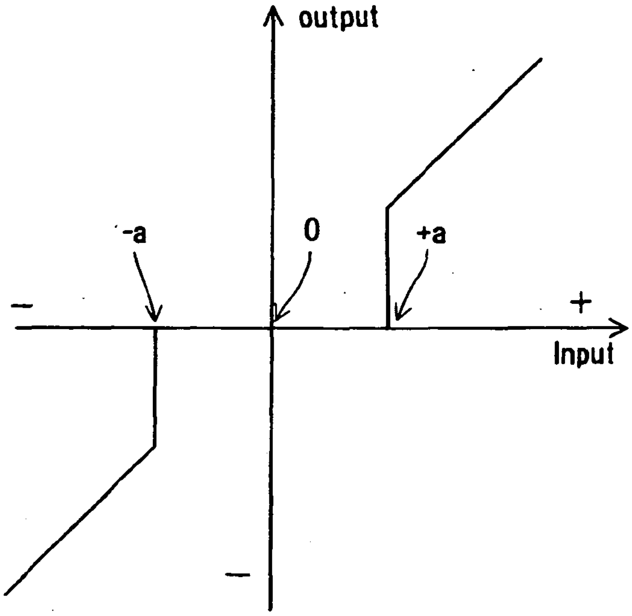


FIG. 8

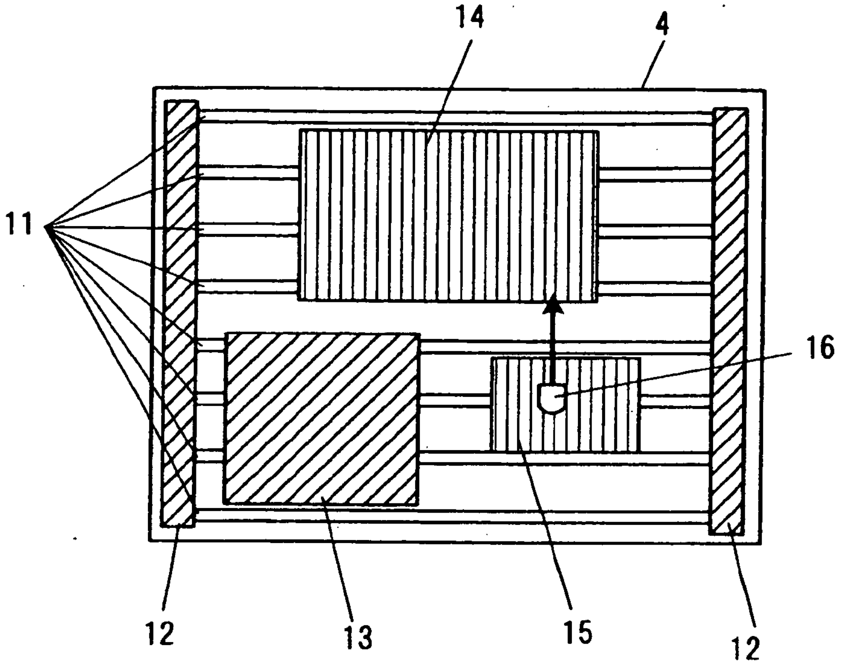


FIG. 9

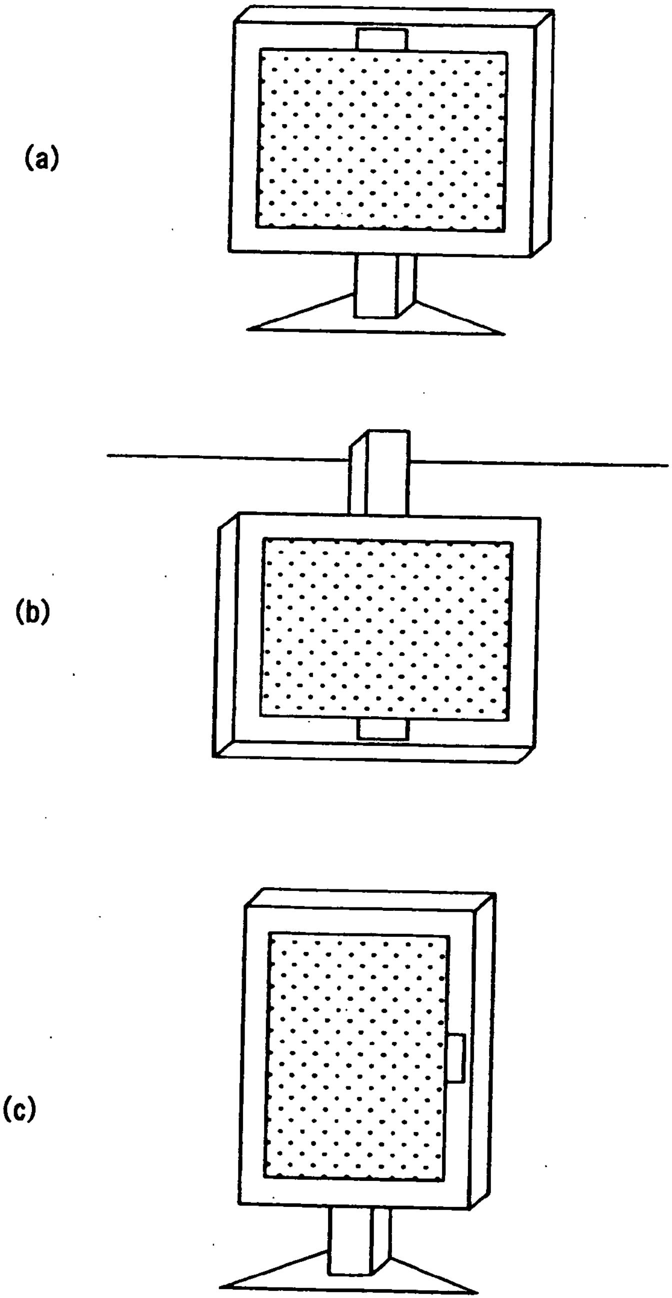


FIG. 10

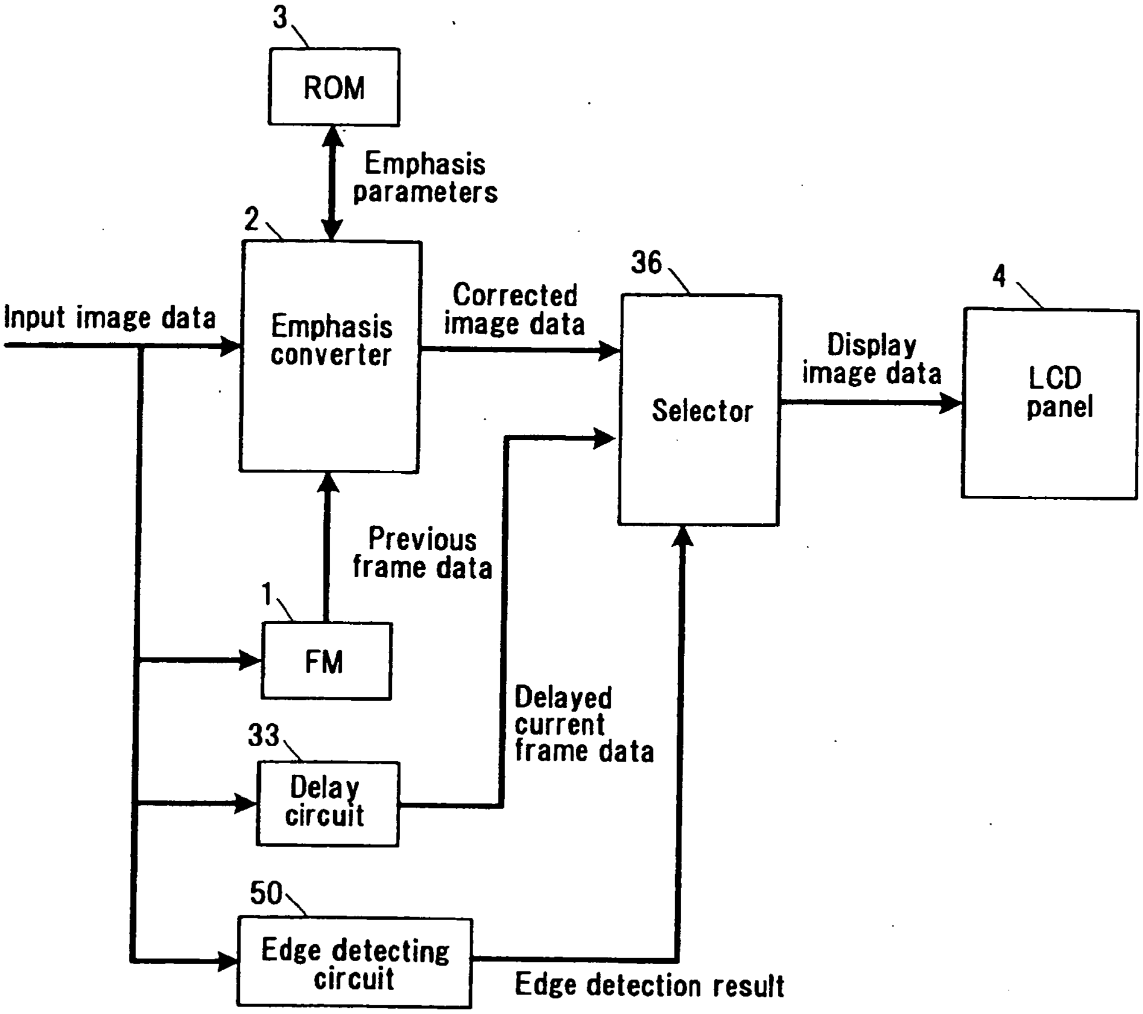

3
ROM
Emphasis parameters
2
Emphasis converter
Input image data
Corrected image data
36
Selector
Display image data
4
LCD panel
Previous frame data
1
FM
33
Delay circuit
Delayed current frame data
50
Edge detecting circuit
Edge detection result

FIG. 11

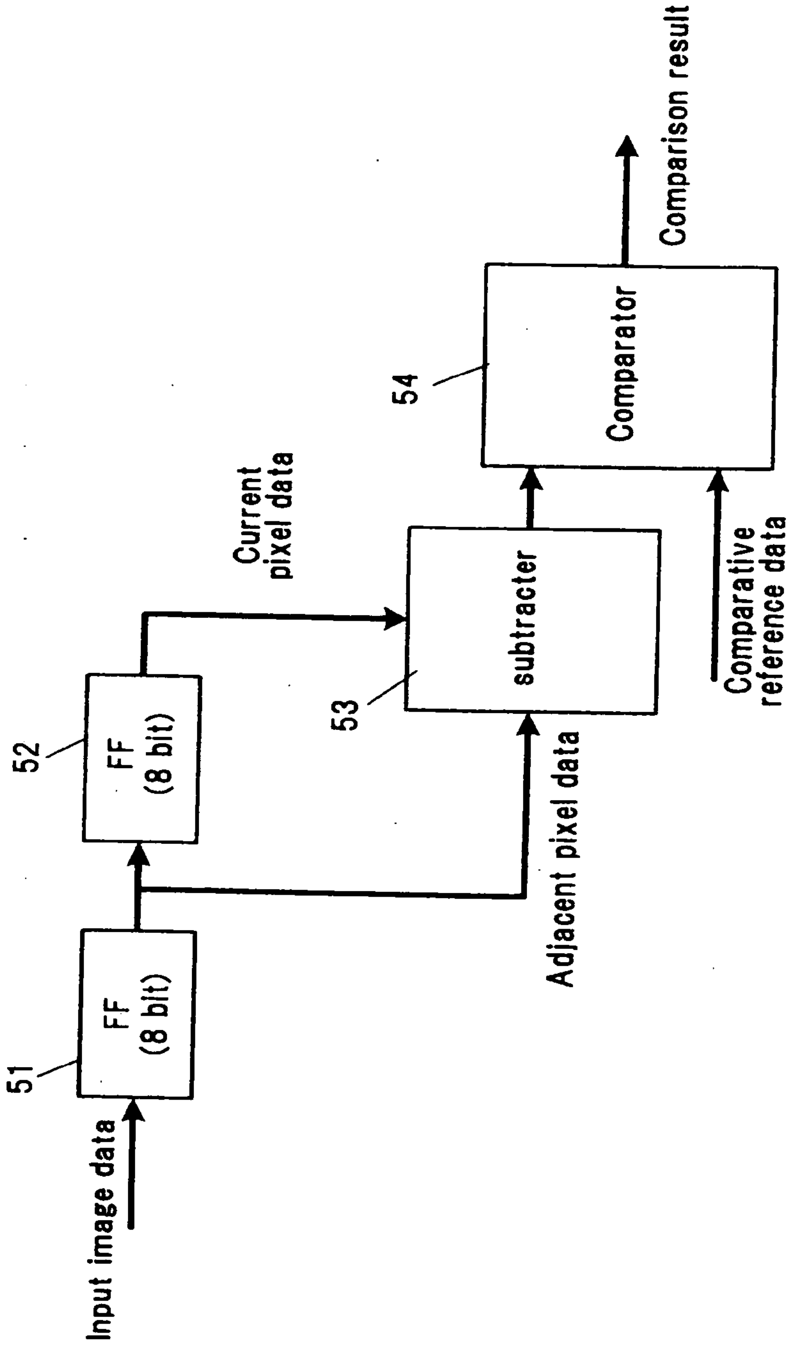

Input image data
51
FF
(8 bit)
52
FF
(8 bit)
Current
pixel data
Adjacent pixel data
53
subtracter
54
Comparator
Comparative
reference data
Comparison result

FIG. 12

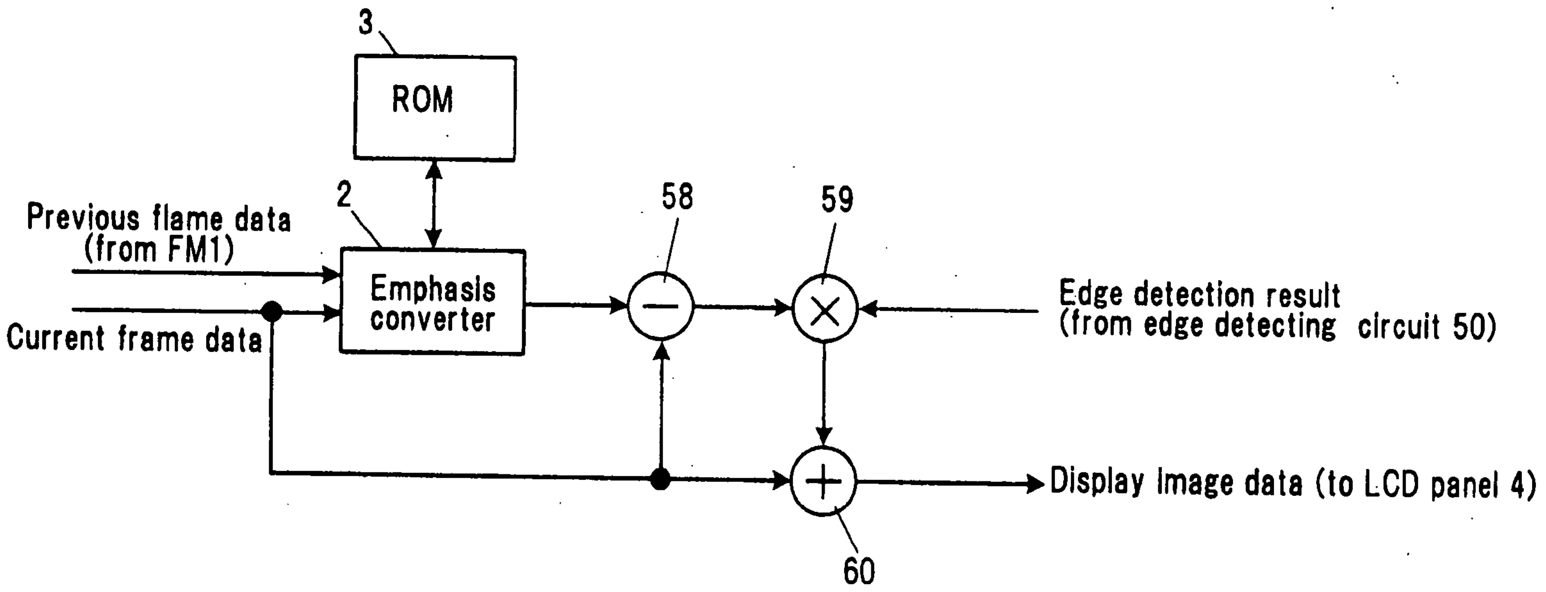

3
ROM
2
Emphasis converter
Previous flame data (from FM1)
Current frame data
58
59
60
Edge detection result (from edge detecting circuit 50)
Display Image data (to LCD panel 4)

FIG. 13

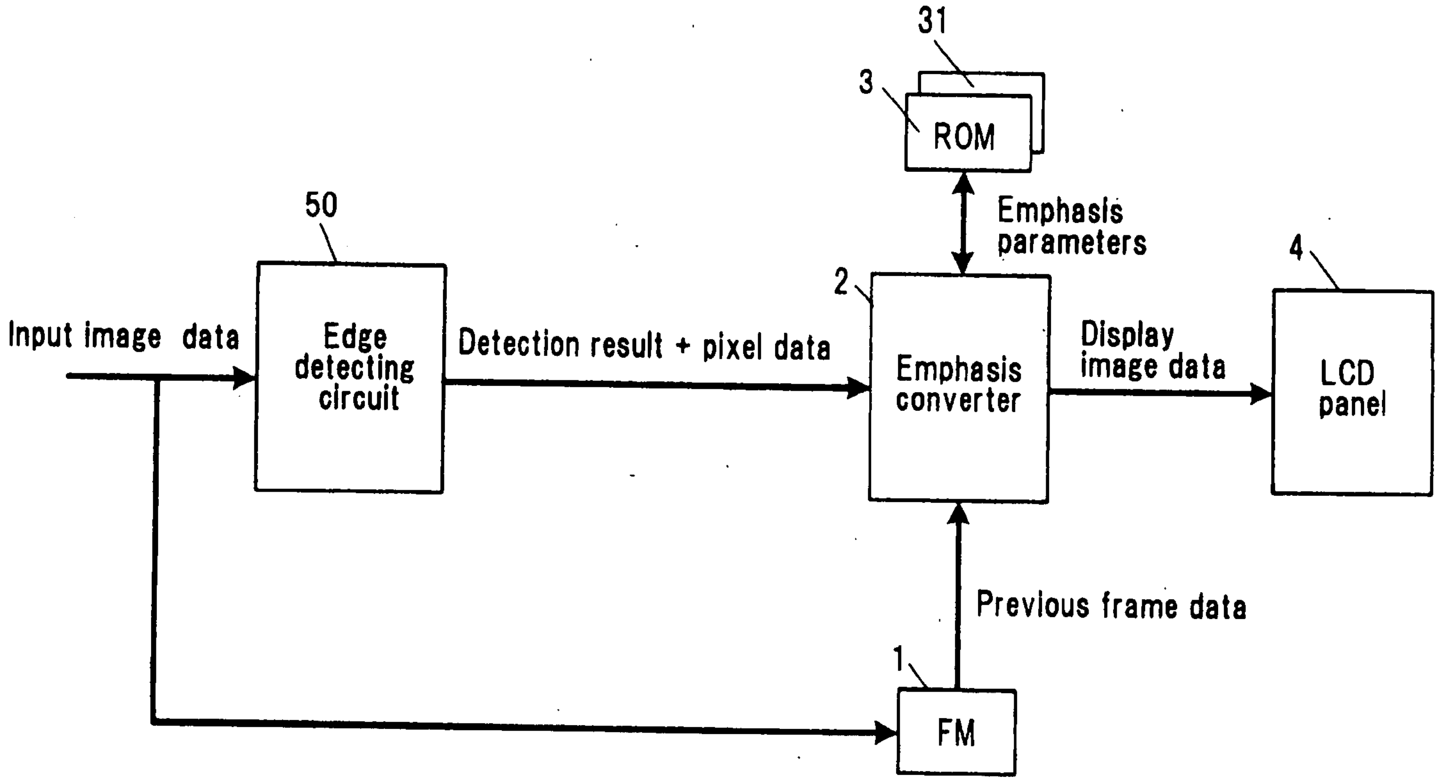

31
3
ROM
50
Emphasis parameters
4
2
Input image data
Edge detecting circuit
Detection result + pixel data
Emphasis converter
Display image data
LCD panel
Previous frame data
1
FM

FIG. 14

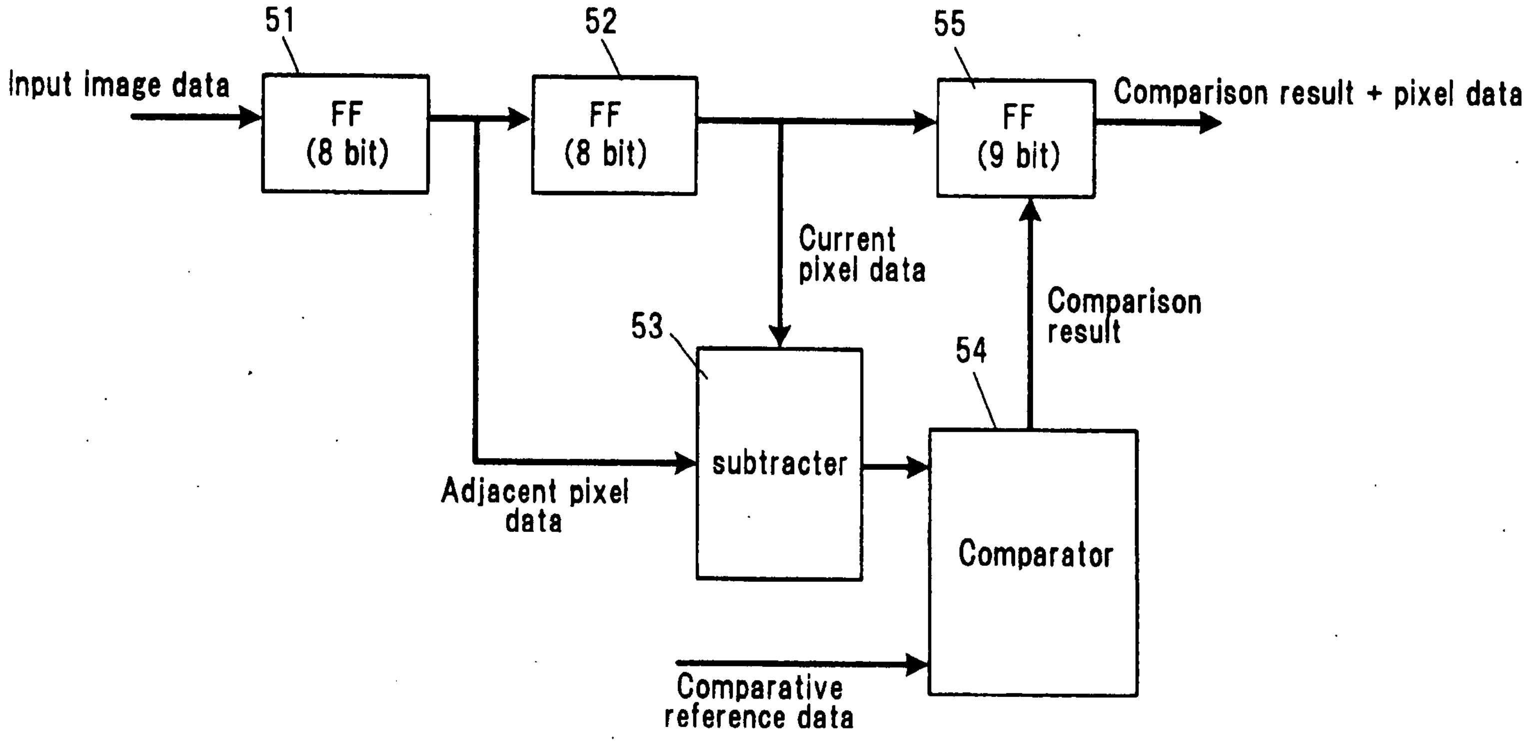

51
52
55
Input image data
FF
(8 bit)
FF
(8 bit)
FF
(9 bit)
Comparison result + pixel data
Current
pixel data
53
subtracter
Adjacent pixel
data
54
Comparison
result
Comparator
Comparative
reference data

FIG. 15

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	32	64	96	128	160	192	224	255
32	0	32	64	96	128	160	192	224	255
64	0	32	64	96	128	160	192	224	255
96	0	32	64	96	128	160	192	224	255
128	0	32	64	96	128	160	192	224	255
160	0	32	64	96	128	160	192	224	255
192	0	32	64	96	128	160	192	224	255
224	0	32	64	96	128	160	192	224	255
255	0	32	64	96	128	160	192	224	255

FIG. 16

Current frame data

Previous frame data

		0	32	64	96	128	160	192	224	255
Non-conversion parameter area	0									
	32									
	64									
	96									
	128									
	160									
	192									
	224									
	255									
Conversion parameter area	0									
	• • • • •									
	255									

FIG. 17

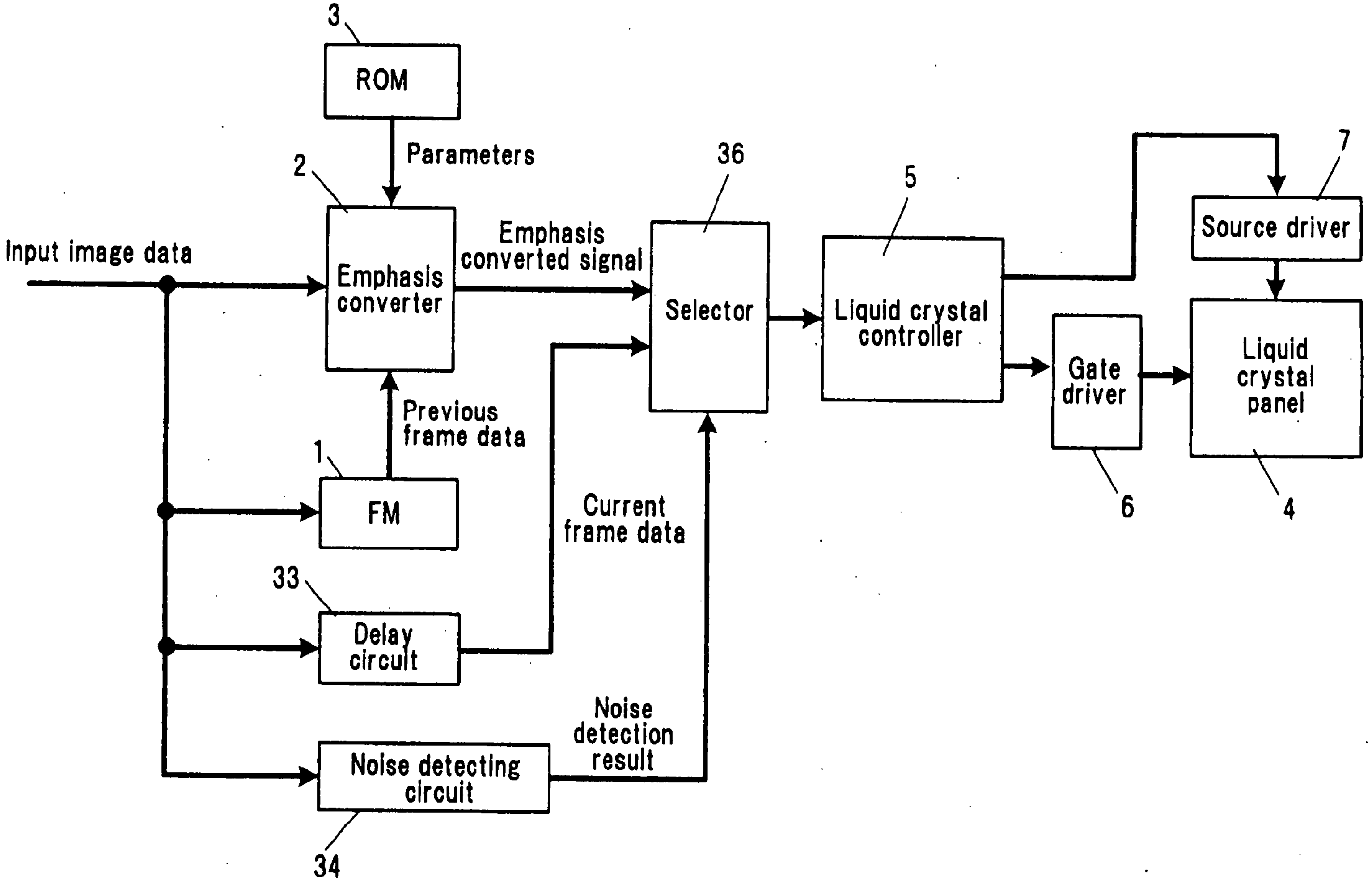

3
ROM
Parameters
2
Input image data
Emphasis converter
Emphasis converted signal
36
Selector
5
Liquid crystal controller
7
Source driver
Gate driver
Liquid crystal panel
6
4
Previous frame data
1
FM
Current frame data
33
Delay circuit
Noise detection result
Noise detecting circuit
34

FIG. 18

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	51	118	165	194	214	230	242	255
32	0	32	120	159	183	206	226	240	255
64	0	12	64	110	150	182	209	234	255
96	0	0	48	96	140	175	204	232	255
128	0	0	43	81	128	167	201	232	255
160	0	0	35	66	117	160	196	229	255
192	0	0	2	56	105	152	192	227	255
224	0	0	0	50	85	139	186	224	255
255	0	0	0	44	75	136	181	215	255

Table content in ROM 3

FIG. 19

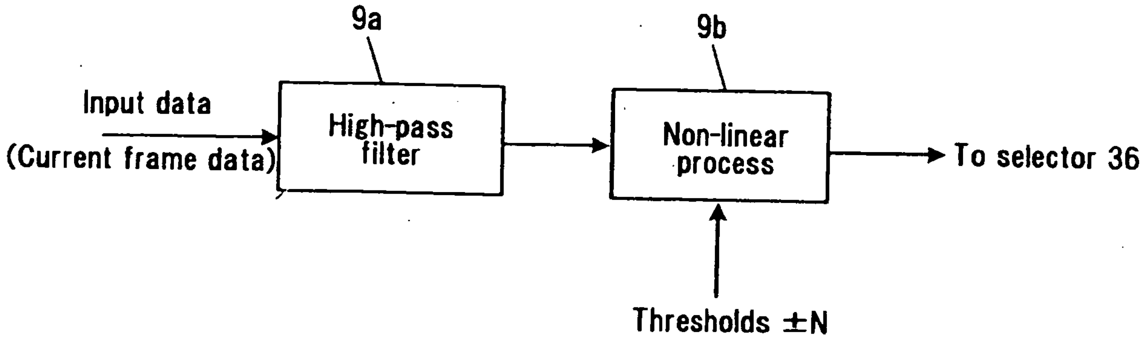

9a
9b
Input data
(Current frame data)
High-pass filter
Non-linear process
To selector 36
Thresholds ±N

FIG. 20

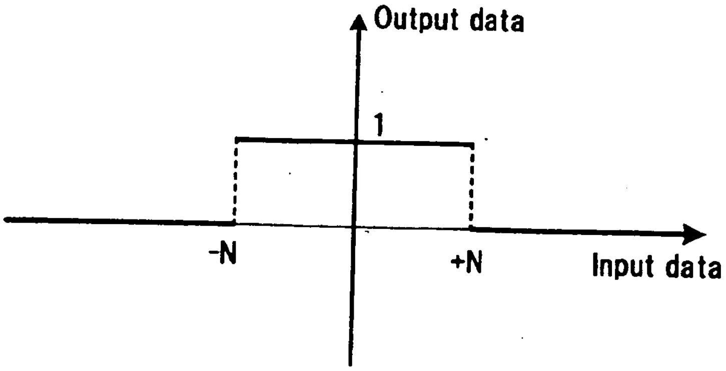

Output data
1
-N
+N
Input data

FIG. 21

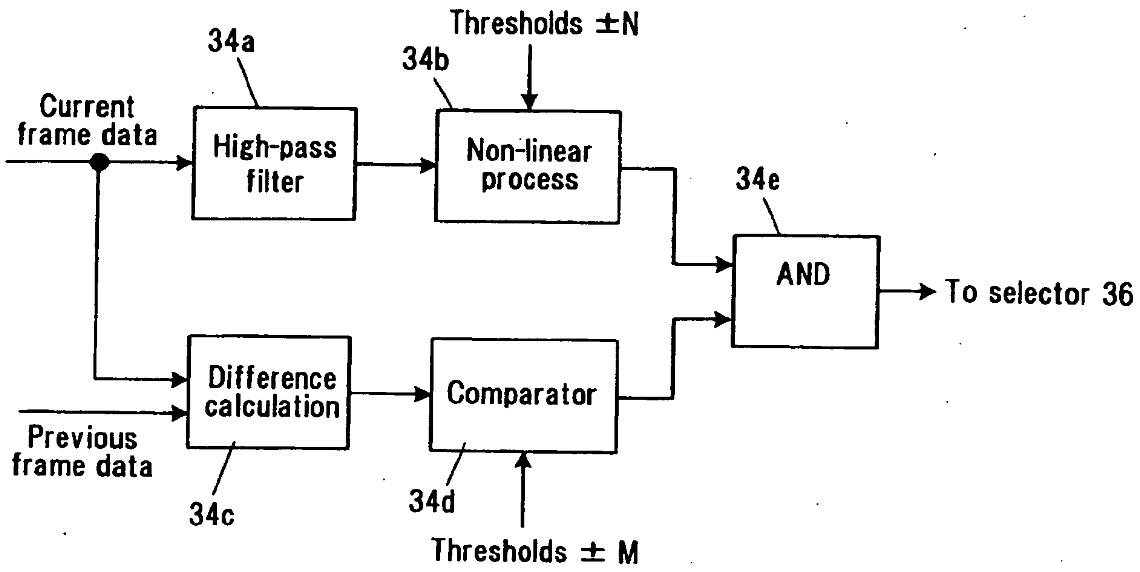

Thresholds ±N
34a
34b
Current
frame data
High-pass
filter
Non-linear
process
34e
AND
To selector 36
Difference
calculation
Comparator
Previous
frame data
34c
34d
Thresholds ± M

FIG. 22

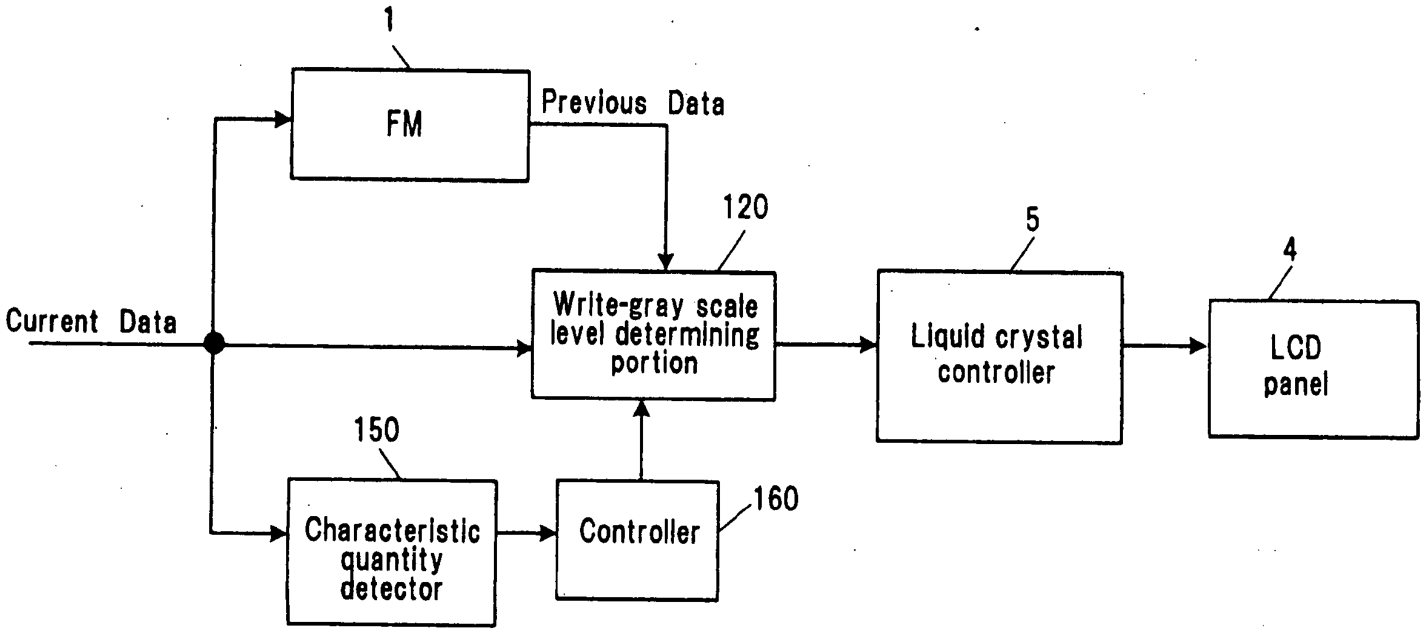

1
FM
Previous Data
120
Write-gray scale level determining portion
5
Liquid crystal controller
4
LCD panel
Current Data
150
Characteristic quantity detector
Controller
160

FIG. 23

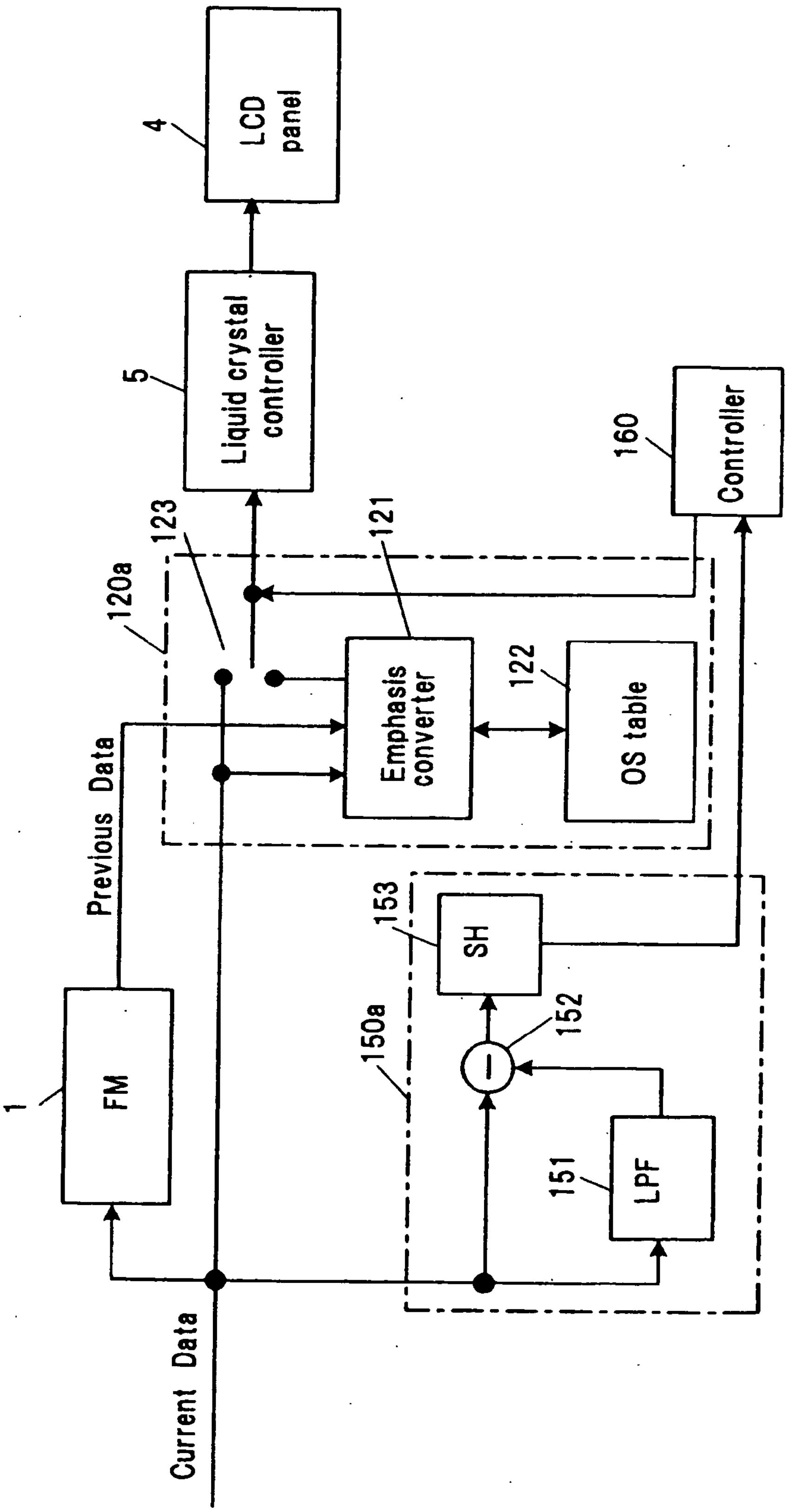

Current Data
Previous Data
1
FM
120a
123
121
Emphasis converter
122
OS table
5
Liquid crystal controller
4
LCD panel
160
Controller
150a
153
SH
152
151
LPF

FIG. 24

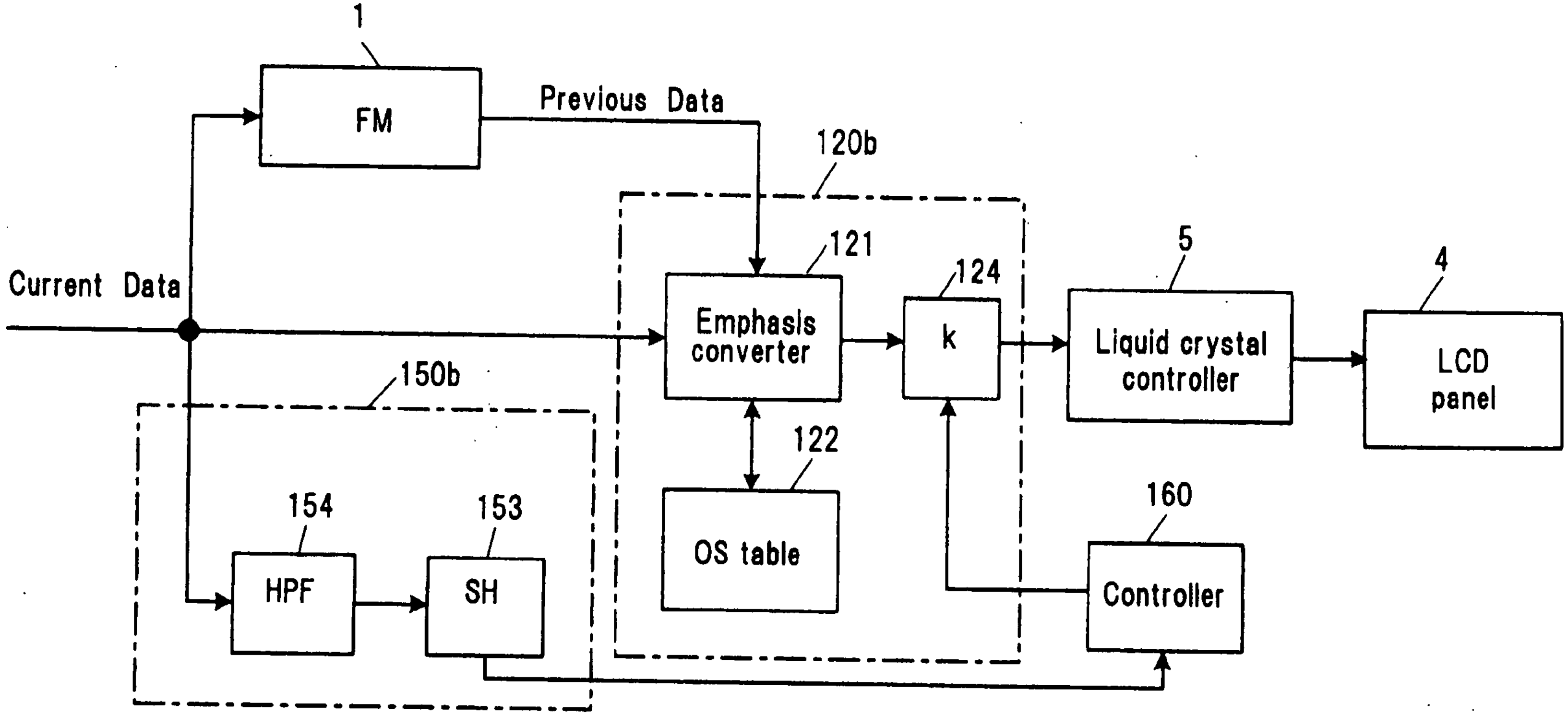

1
FM
Previous Data
120b
121
Current Data
Emphasis converter
124
k
5
Liquid crystal controller
4
LCD panel
150b
122
OS table
154
HPF
153
SH
160
Controller

FIG. 25

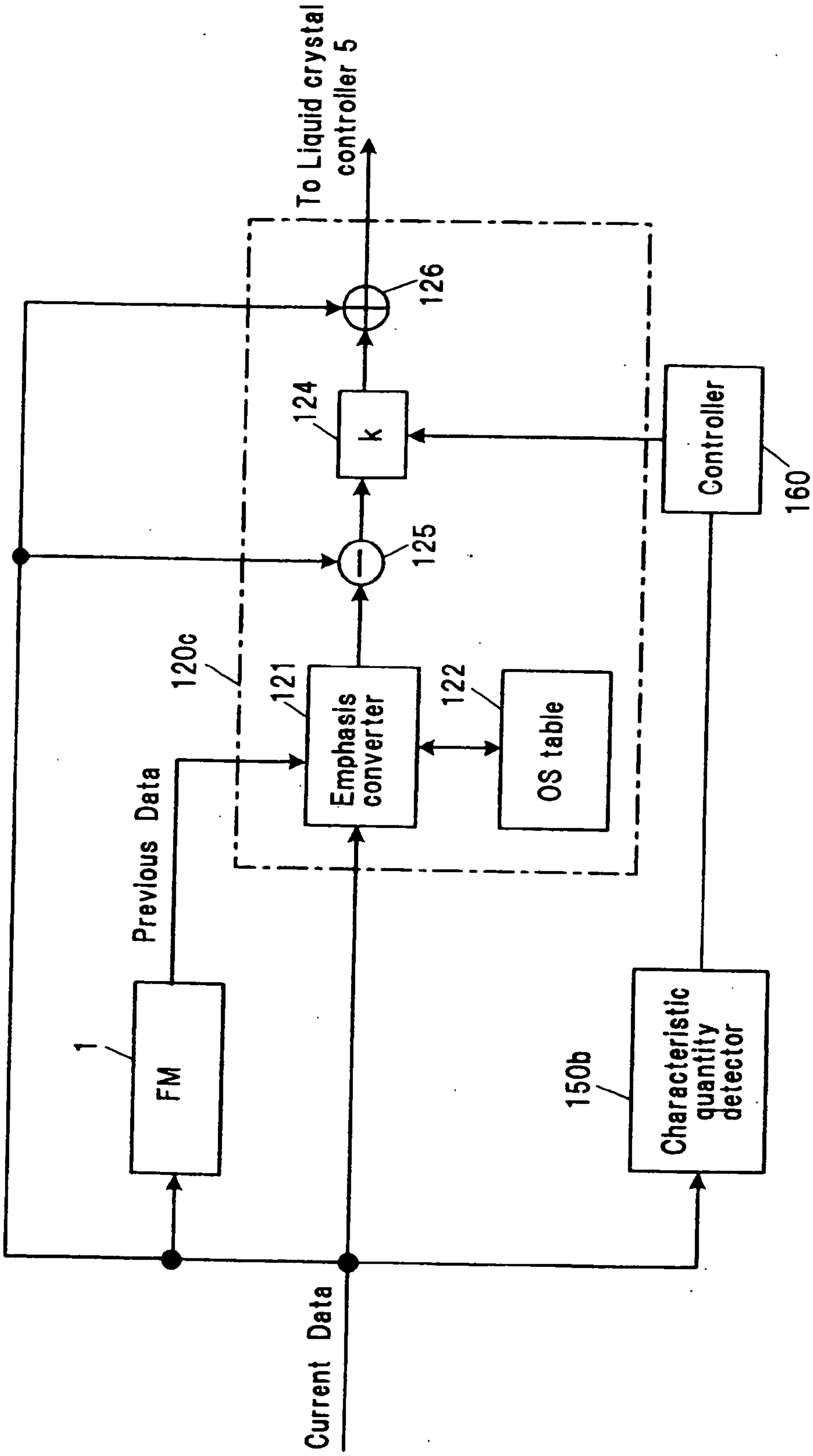

To Liquid crystal controller 5
126
124
k
125
Controller
160
120c
121
Emphasis converter
122
OS table
Previous Data
1
FM
150b
Characteristic quantity detector
Current Data

FIG. 26

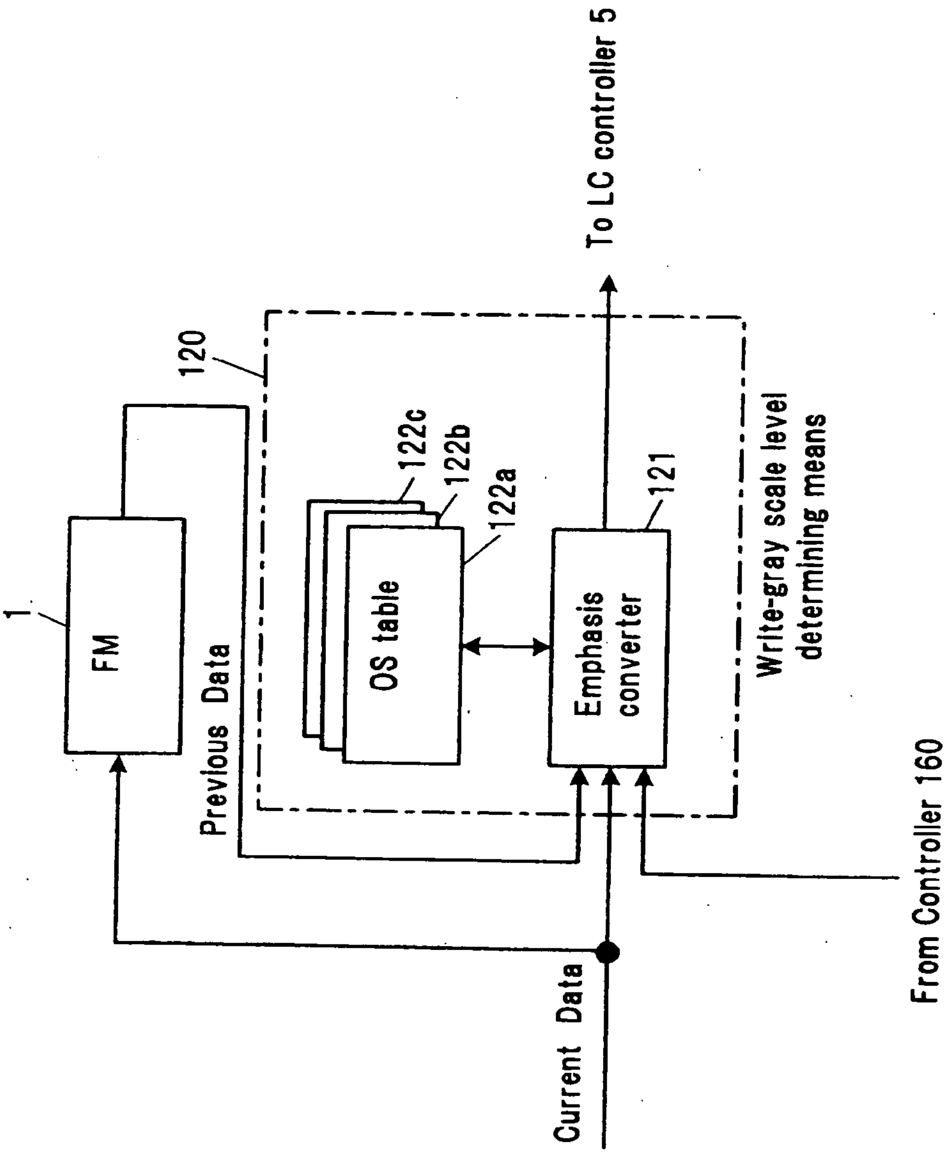

1
FM
Previous Data
120
OS table
122c
122b
122a
Emphasis converter
121
Write-gray scale level determining means
To LC controller 5
Current Data
From Controller 160

FIG. 27

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	51	118	165	194	214	230	242	255
32	0	32	120	159	183	206	226	240	255
64	0	12	64	110	150	182	209	234	255
96	0	0	48	96	140	175	204	232	255
128	0	0	43	81	128	167	201	232	255
160	0	0	35	66	117	160	196	229	255
192	0	0	2	56	105	152	192	227	255
224	0	0	0	50	85	139	186	224	255
255	0	0	0	44	75	136	181	215	255

FIG. 28

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	70	147	182	206	227	241	255	255
32	0	32	94	142	177	202	224	239	255
64	0	0	64	116	157	193	218	241	255
96	0	0	31	96	141	177	209	234	255
128	0	0	18	71	128	169	203	232	255
160	0	0	0	53	111	160	199	230	255
192	0	0	0	29	92	148	192	228	255
224	0	0	0	13	55	133	183	224	255
255	0	0	0	0	48	117	173	220	255

FIG. 29

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	32	64	96	128	160	192	224	255
32	0	32	64	96	128	160	192	224	255
64	0	32	64	96	128	160	192	224	255
96	0	32	64	96	128	160	192	224	255
128	0	32	64	96	128	160	192	224	255
160	0	32	64	96	128	160	192	224	255
192	0	32	64	96	128	160	192	224	255
224	0	32	64	96	128	160	192	224	255
255	0	32	64	96	128	160	192	224	255

FIG. 30

Current frame data

Previous frame data

		0	32	64	96	128	160	192	224	225
LEVEL 0	0									
	32									
	64									
	96									
	128									
	160									
	192									
	224									
	255									
LEVEL 1	0									
	• • •									
	255									
LEVEL 2	0									
	• • •									
	255									

FIG. 31

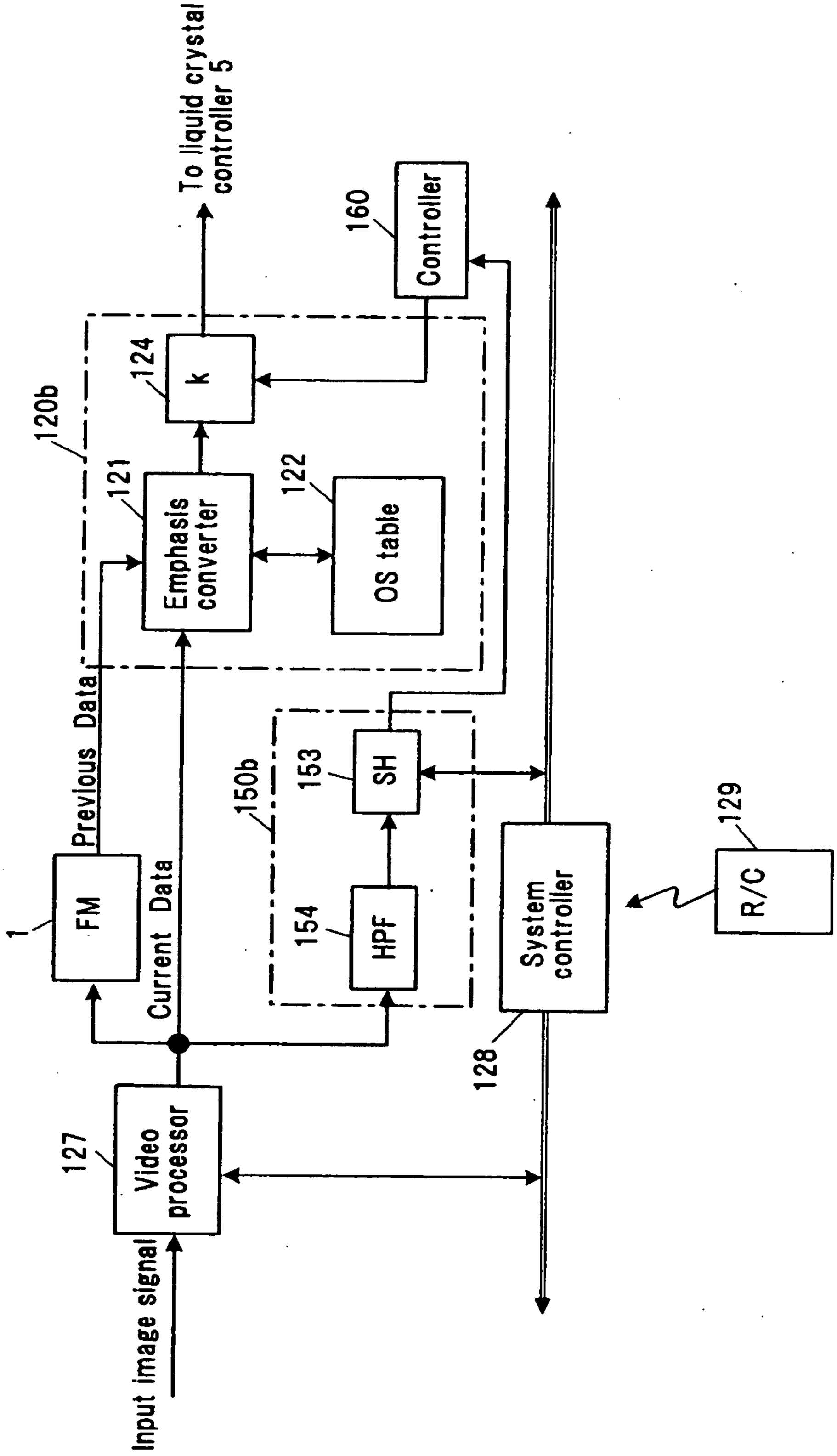

Input image signal
127
Video processor
1
FM
Current Data
Previous Data
120b
121
Emphasis converter
122
OS table
124
k
To liquid crystal controller 5
160
Controller
150b
153
SH
154
HPF
128
System controller
129
R/C

FIG. 32

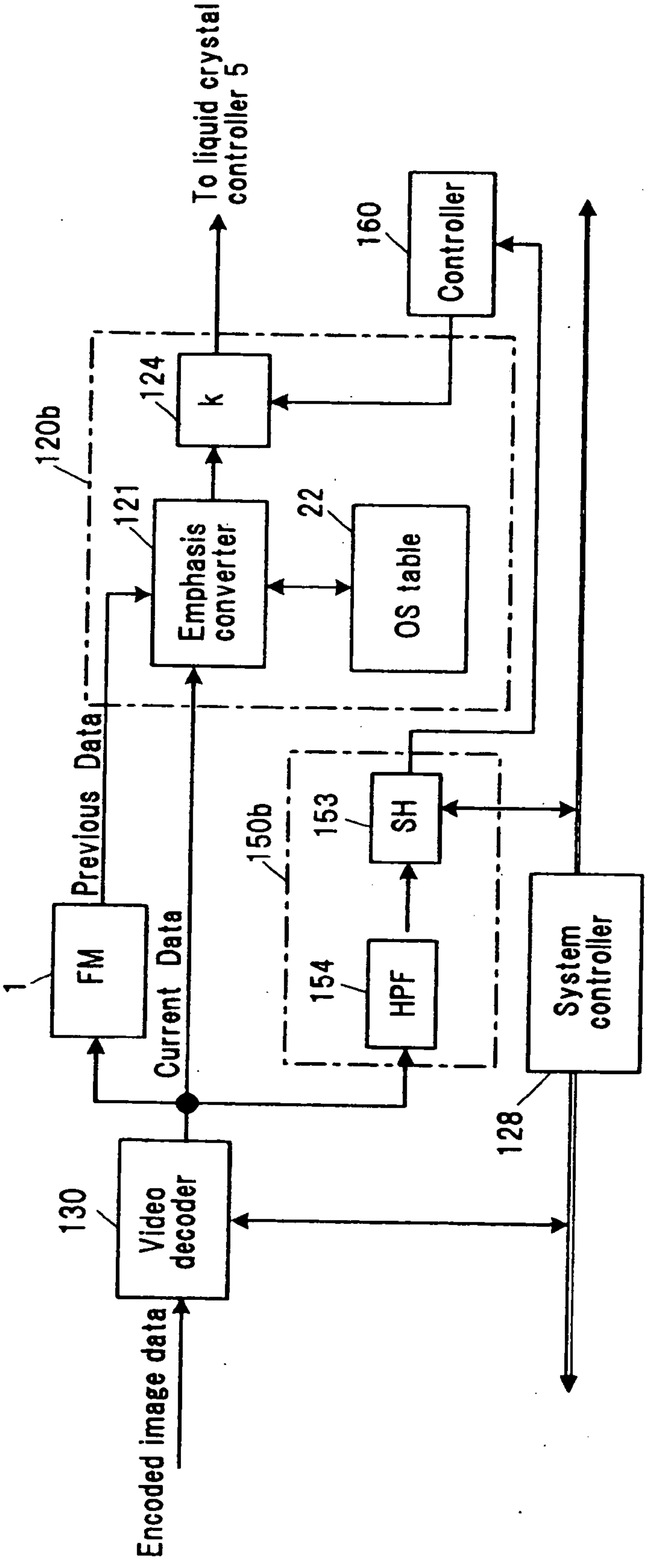

To liquid crystal controller 5
160
Controller
120b
124
k
121
Emphasis converter
22
OS table
Previous Data
150b
153
SH
1
FM
Current Data
154
HPF
System controller
128
130
Video decoder
Encoded image data

FIG. 33

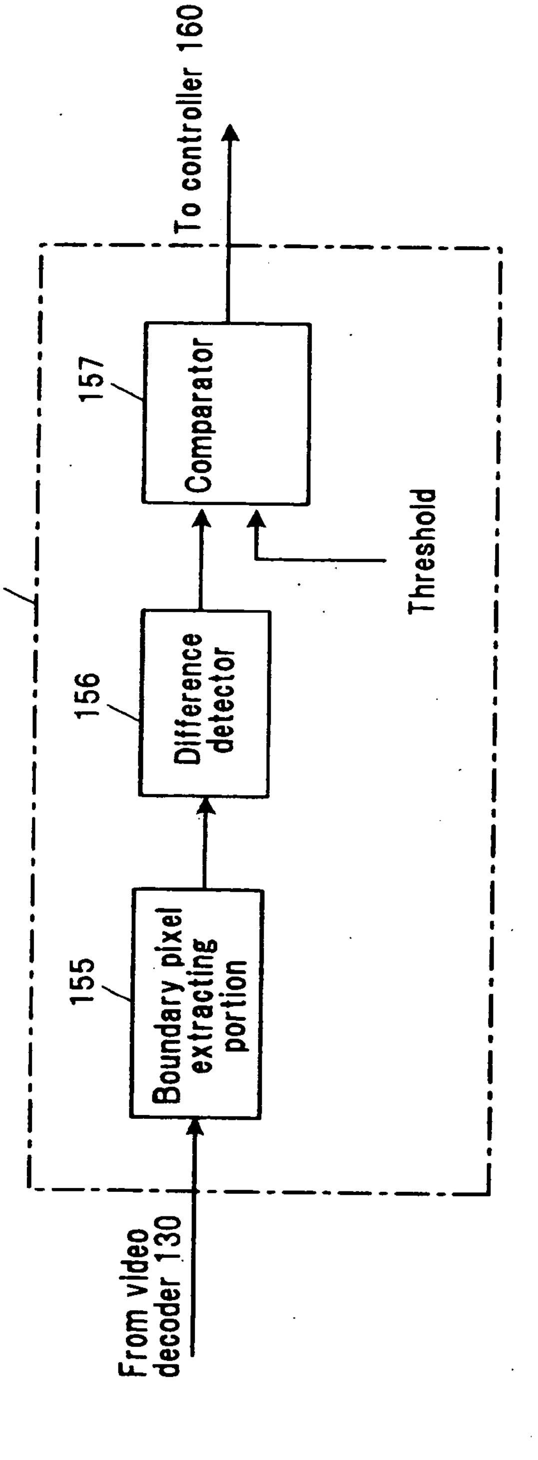

150c
155
Boundary pixel extracting portion
156
Difference detector
157
Comparator
Threshold
From video decoder 130
To controller 160

FIG. 34

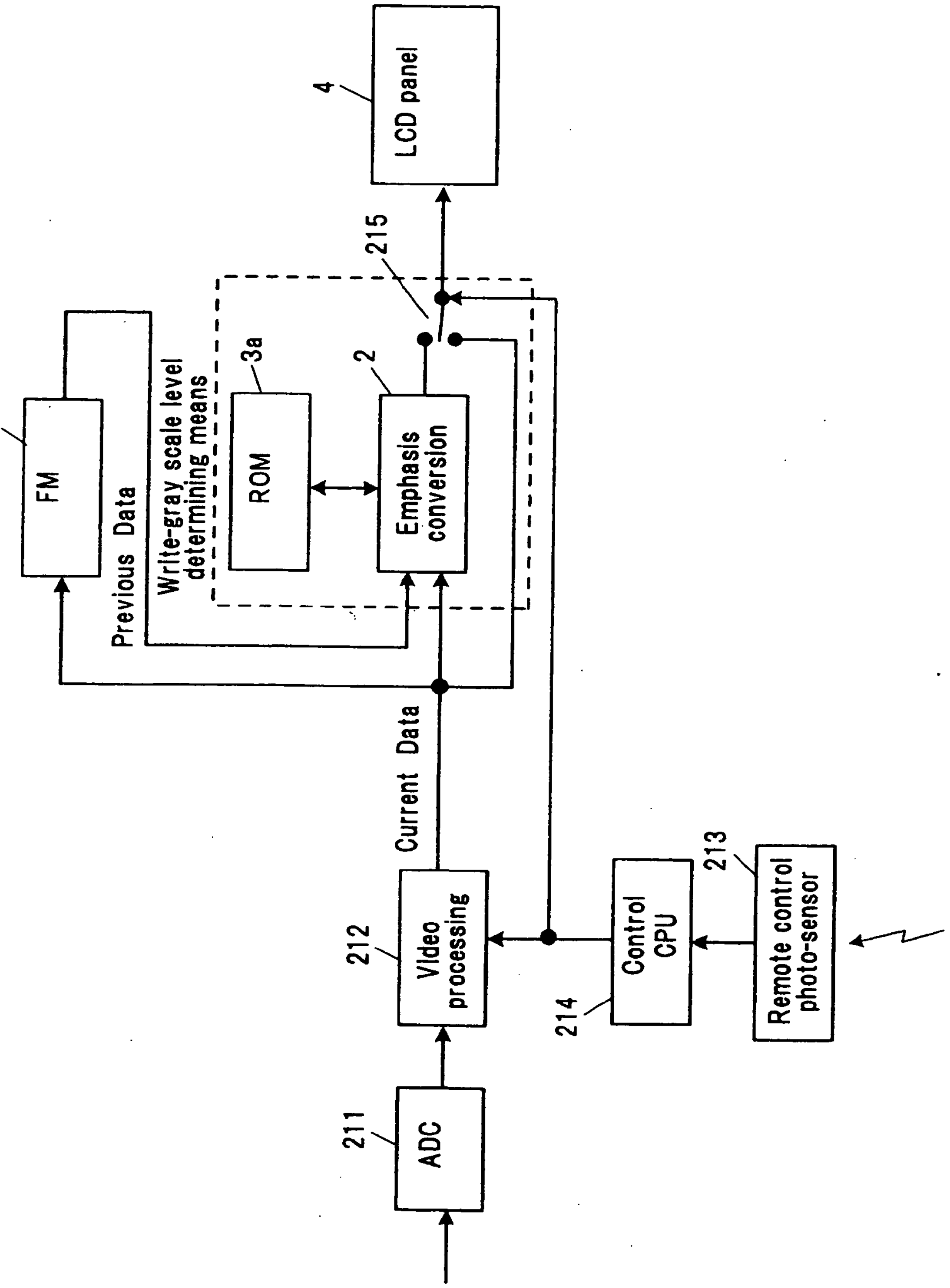

1
FM
Previous Data
Write-gray scale level determining means
3a
ROM
2
Emphasis conversion
215
4
LCD panel
Current Data
212
Video processing
211
ADC
214
Control CPU
213
Remote control photo-sensor

FIG. 35

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	70	147	182	206	227	241	255	255
32	0	32	94	142	177	202	224	239	255
64	0	0	64	116	157	193	218	241	255
96	0	0	31	96	141	177	209	234	255
128	0	0	18	71	128	169	203	232	255
160	0	0	0	53	111	160	199	230	255
192	0	0	0	29	92	148	192	228	255
224	0	0	0	13	55	133	183	224	255
255	0	0	0	0	48	117	173	220	255

Table content in ROM 3a

FIG. 36

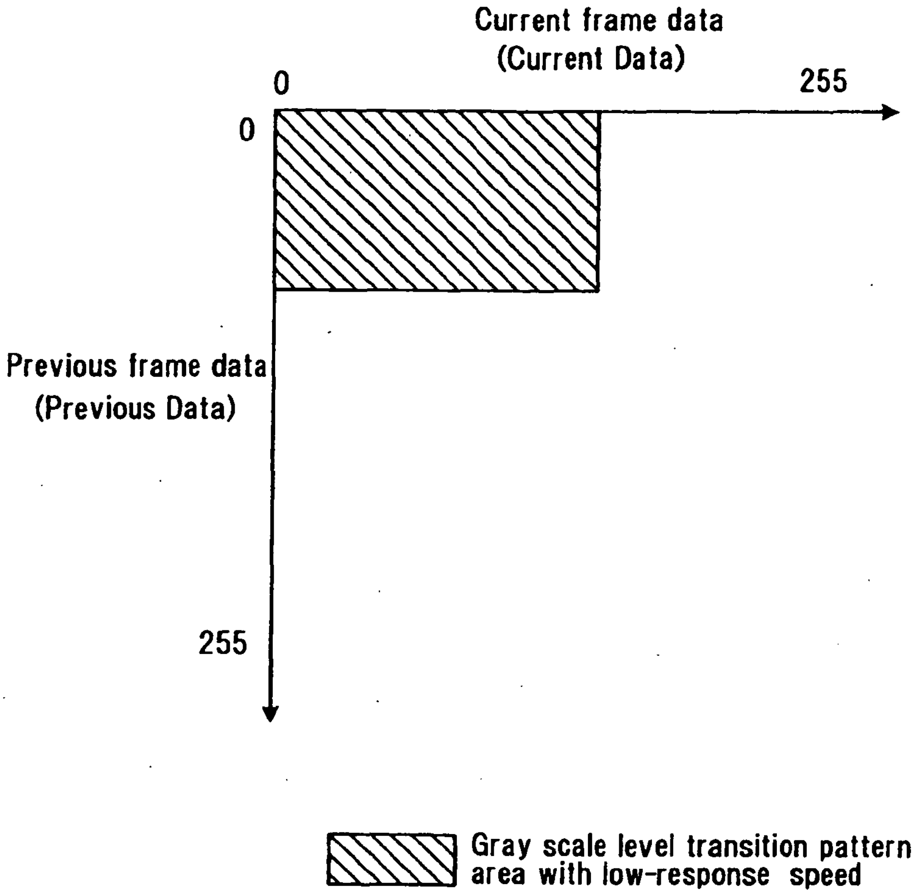

Current frame data
(Current Data)
0
255
0
Previous frame data
(Previous Data)
255
Gray scale level transition pattern area with low-response speed

FIG. 37

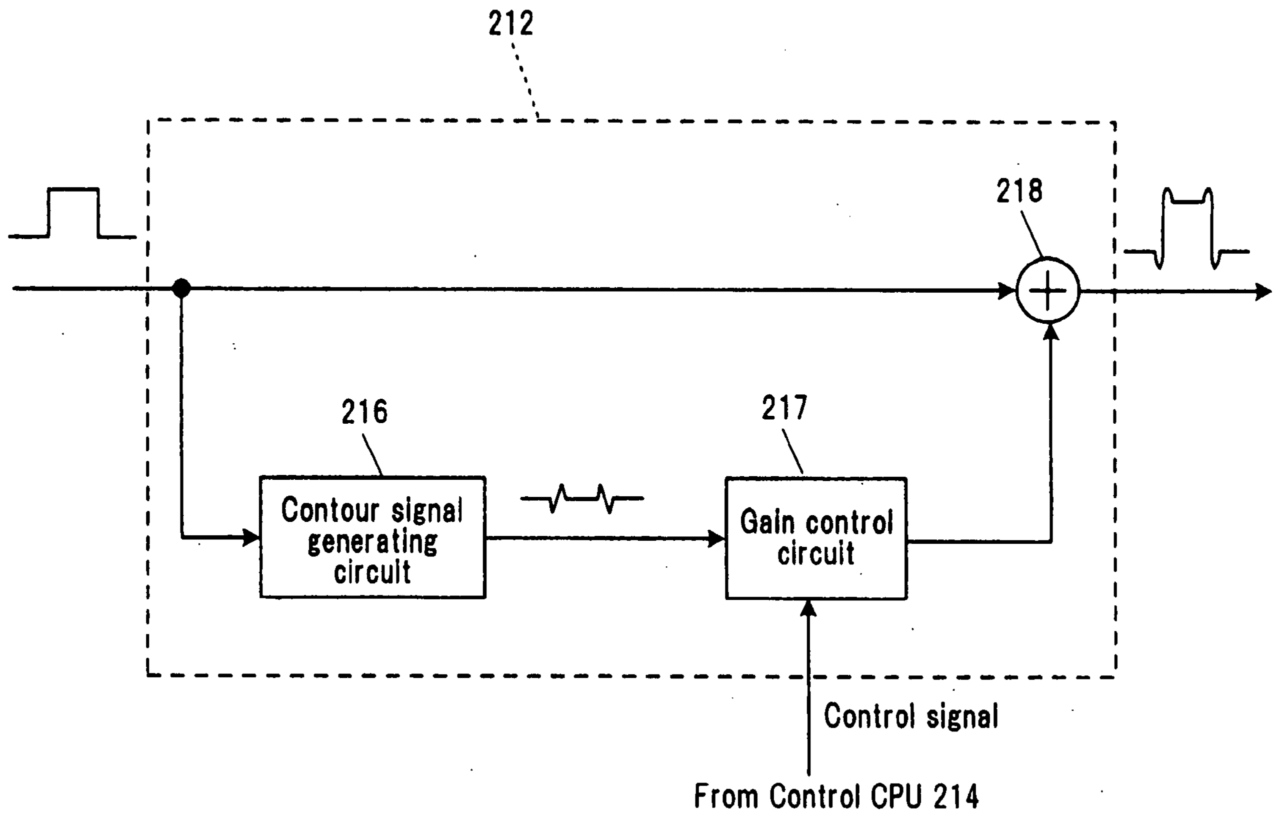

212
218
216
Contour signal generating circuit
217
Gain control circuit
Control signal
From Control CPU 214

FIG. 38

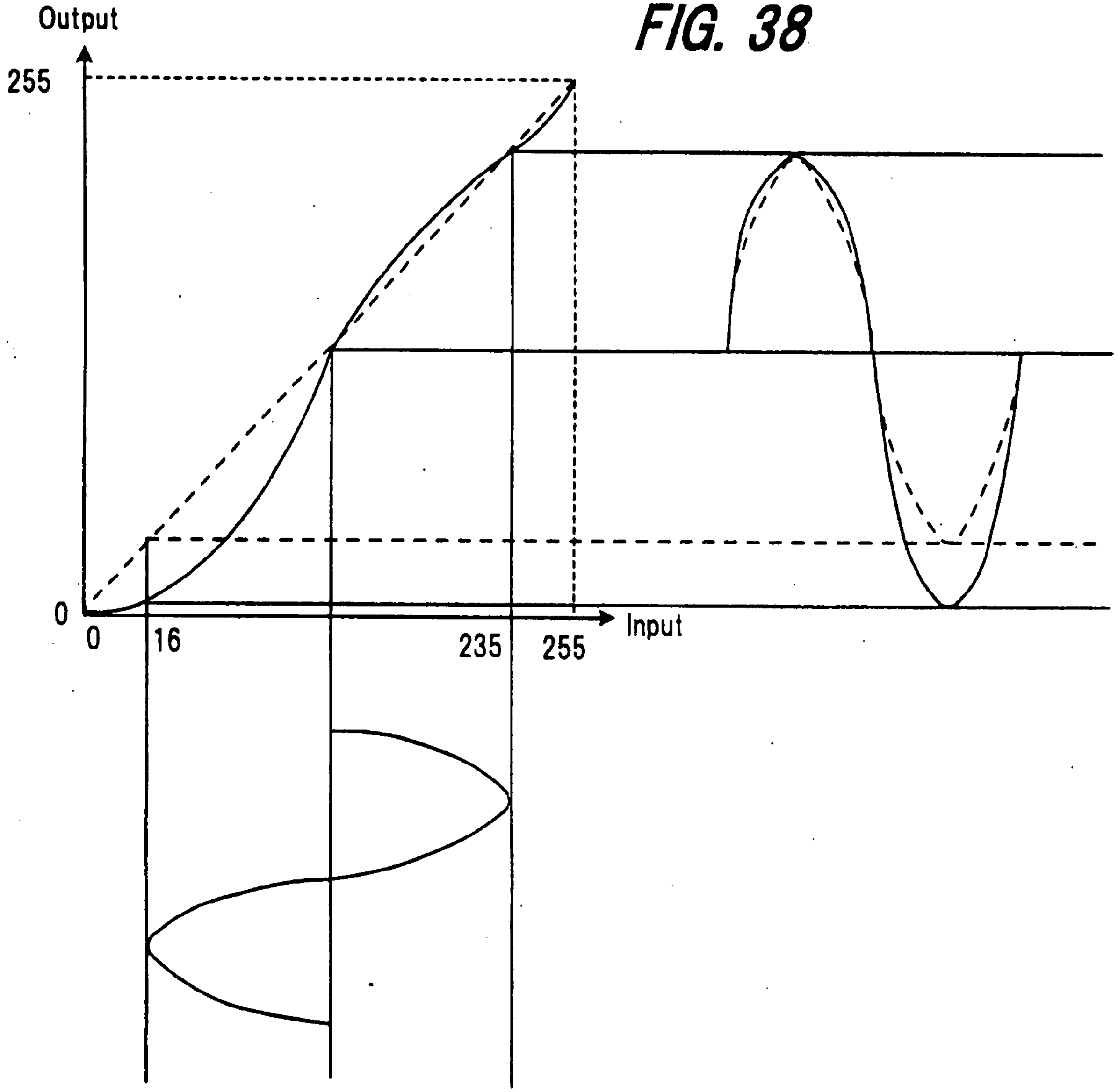


FIG. 39

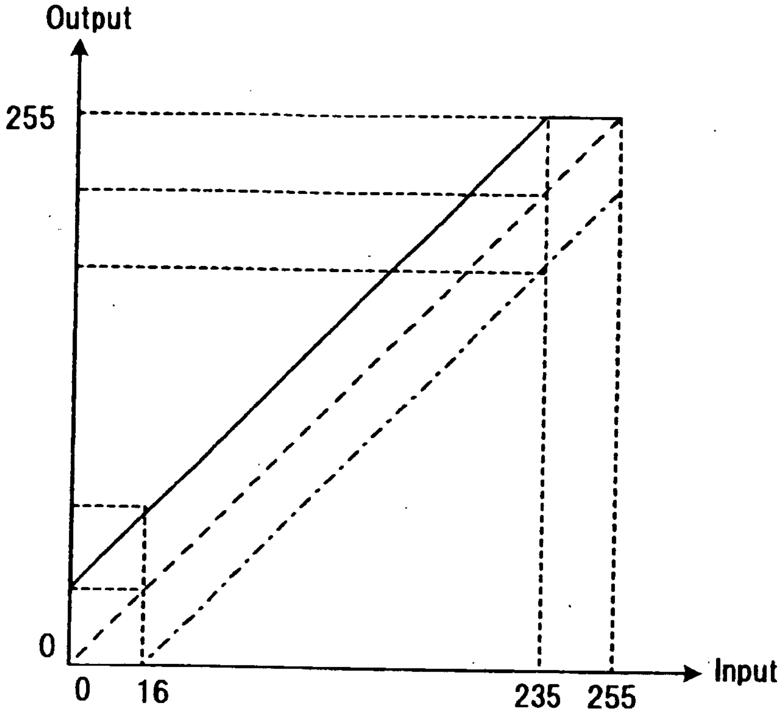


FIG. 40

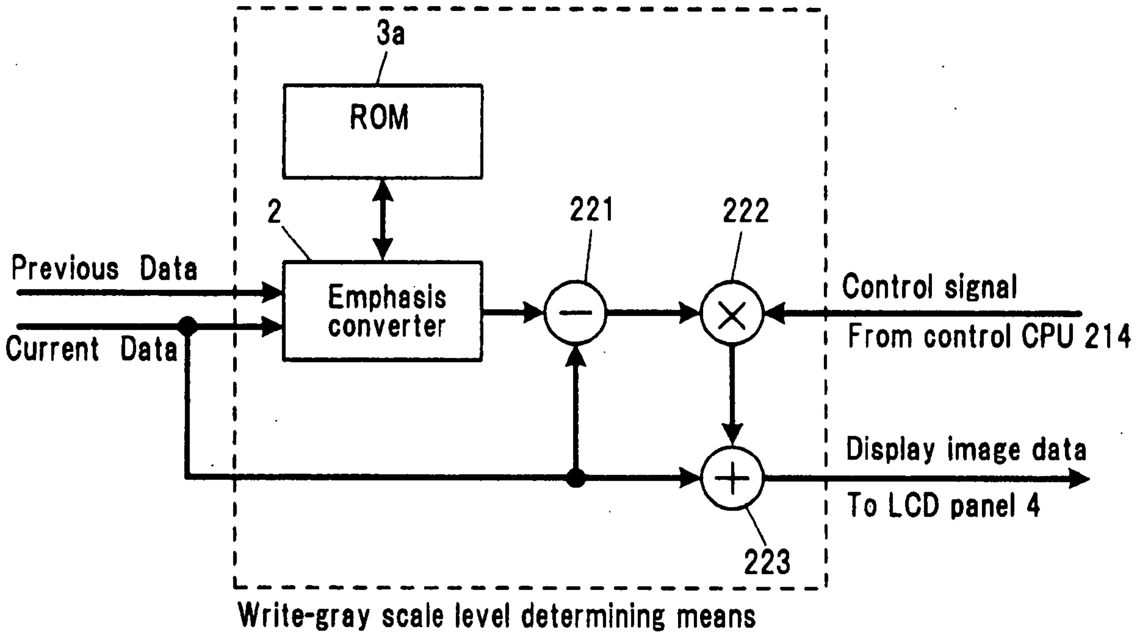

3a
ROM
2
Emphasis converter
221
222
Previous Data
Current Data
Control signal
From control CPU 214
Display image data
To LCD panel 4
223
Write-gray scale level determining means

FIG. 41

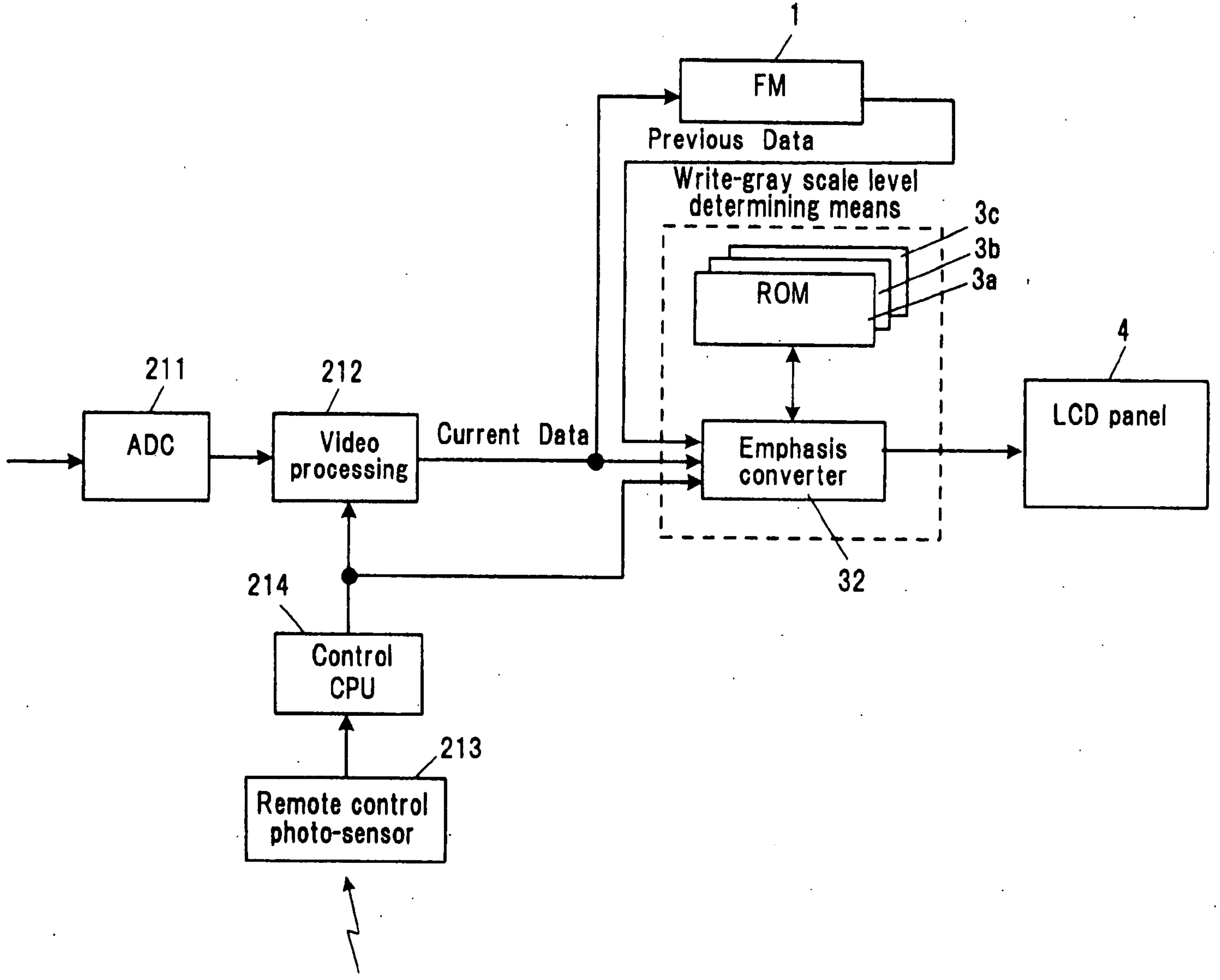

1
FM
Previous Data
Write-gray scale level determining means
3c
3b
3a
ROM
4
LCD panel
211
ADC
212
Video processing
Current Data
Emphasis converter
32
214
Control CPU
213
Remote control photo-sensor

FIG. 42

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	51	118	165	194	214	230	242	255
32	0	32	120	159	183	206	226	240	255
64	0	12	64	110	150	182	209	234	255
96	0	0	48	96	140	175	204	232	255
128	0	0	43	81	128	167	201	232	255
160	0	0	35	66	117	160	196	229	255
192	0	0	2	56	105	152	192	227	255
224	0	0	0	50	85	139	186	224	255
255	0	0	0	44	75	136	181	215	255

Table content in ROM 3b

FIG. 43

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	32	64	96	128	160	192	224	255
32	0	32	64	96	128	160	192	224	255
64	0	32	64	96	128	160	192	224	255
96	0	32	64	96	128	160	192	224	255
128	0	32	64	96	128	160	192	224	255
160	0	32	64	96	128	160	192	224	255
192	0	32	64	96	128	160	192	224	255
224	0	32	64	96	128	160	192	224	255
255	0	32	64	96	128	160	192	224	255

Table content in ROM 3c

FIG. 44

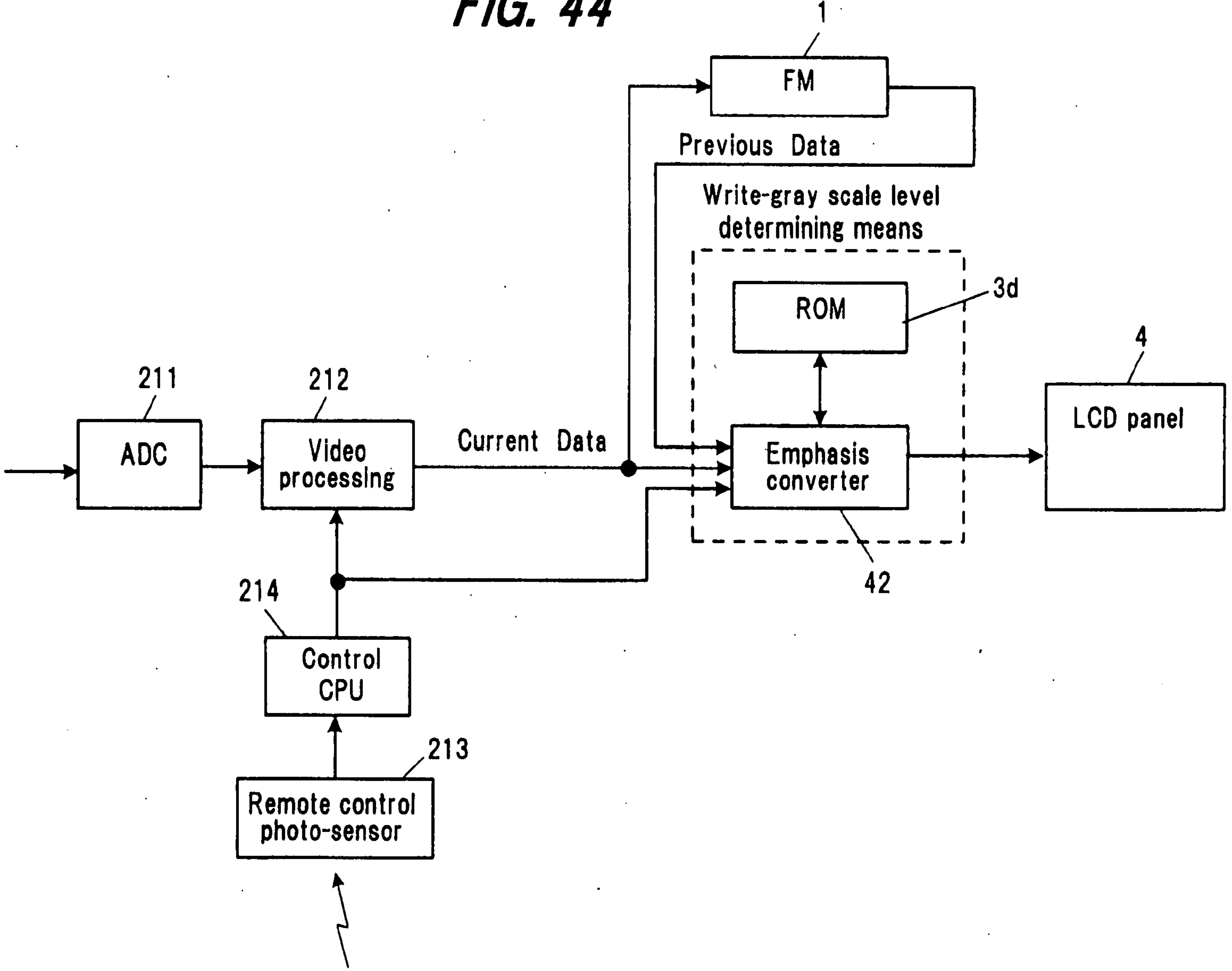

1
FM
Previous Data
Write-gray scale level determining means
ROM
3d
4
LCD panel
211
ADC
212
Video processing
Current Data
Emphasis converter
42
214
Control CPU
213
Remote control photo-sensor

FIG. 45

			Current frame data								
			0	32	64	96	128	160	192	224	225
Previous frame data	Non-conversion table area	0									
		32									
		64									
		96									
		128									
		160									
		192									
		224									
		255									
	Weak-conversion table area	0									
		• • •									
		255									
	Strong-conversion table area	0									
		• • •									
		255									

Table content in ROM 3d

FIG. 46

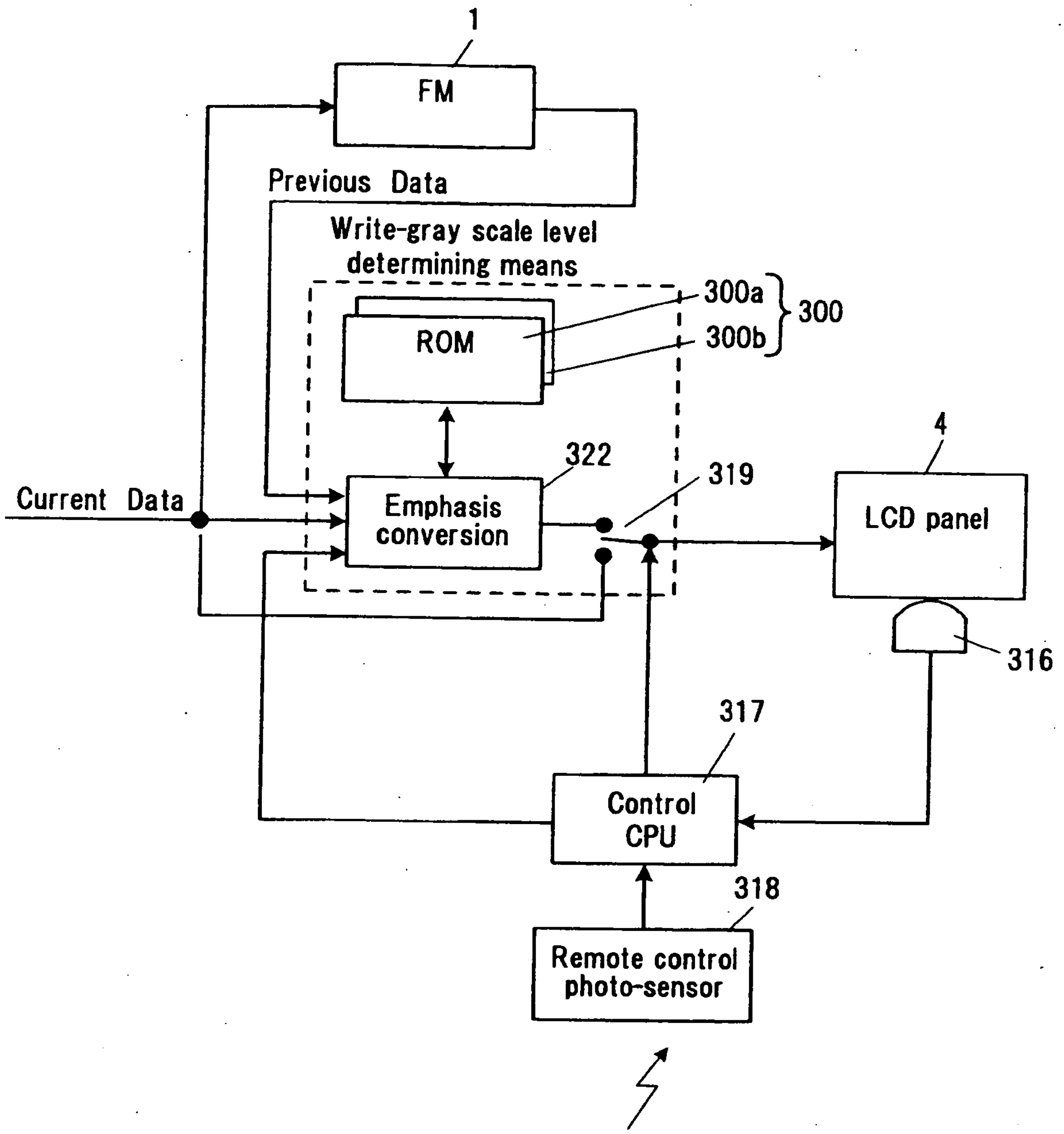

1
FM
Previous Data
Write-gray scale level determining means
300a
300b
300
ROM
322
319
4
Current Data
Emphasis conversion
LCD panel
316
317
Control CPU
318
Remote control photo-sensor

FIG. 47

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	51	118	165	194	214	230	242	255
32	0	32	120	159	183	206	226	240	255
64	0	12	64	110	150	182	209	234	255
96	0	0	48	96	140	175	204	232	255
128	0	0	43	81	128	167	201	232	255
160	0	0	35	66	117	160	196	229	255
192	0	0	2	56	105	152	192	227	255
224	0	0	0	50	85	139	186	224	255
255	0	0	0	44	75	136	181	215	255

(a) Table content in ROM 300b

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	70	147	182	206	227	241	255	255
32	0	32	94	142	177	202	224	239	255
64	0	0	64	116	157	193	218	241	255
96	0	0	31	96	141	177	209	234	255
128	0	0	18	71	128	169	203	232	255
160	0	0	0	53	111	160	199	230	255
192	0	0	0	29	92	148	192	228	255
224	0	0	0	13	55	133	183	224	255
255	0	0	0	0	48	117	173	220	255

(b) Table content in ROM 300a

FIG. 48

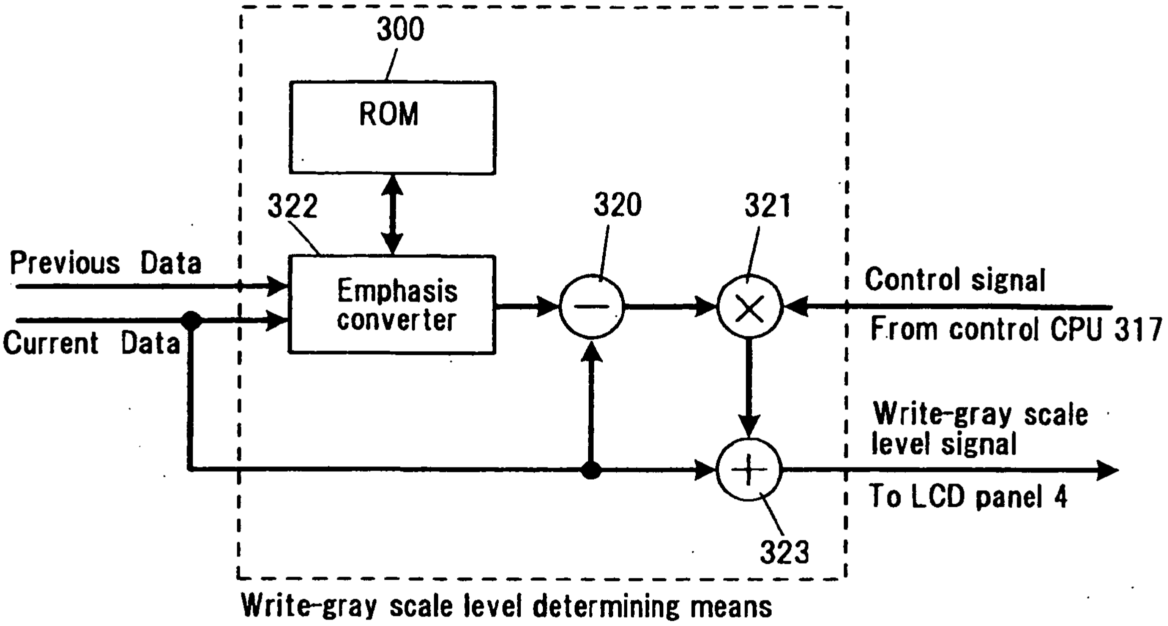

300
ROM
322
Emphasis converter
320
321
Previous Data
Current Data
Control signal
From control CPU 317
Write-gray scale level signal
To LCD panel 4
323
Write-gray scale level determining means

FIG. 49

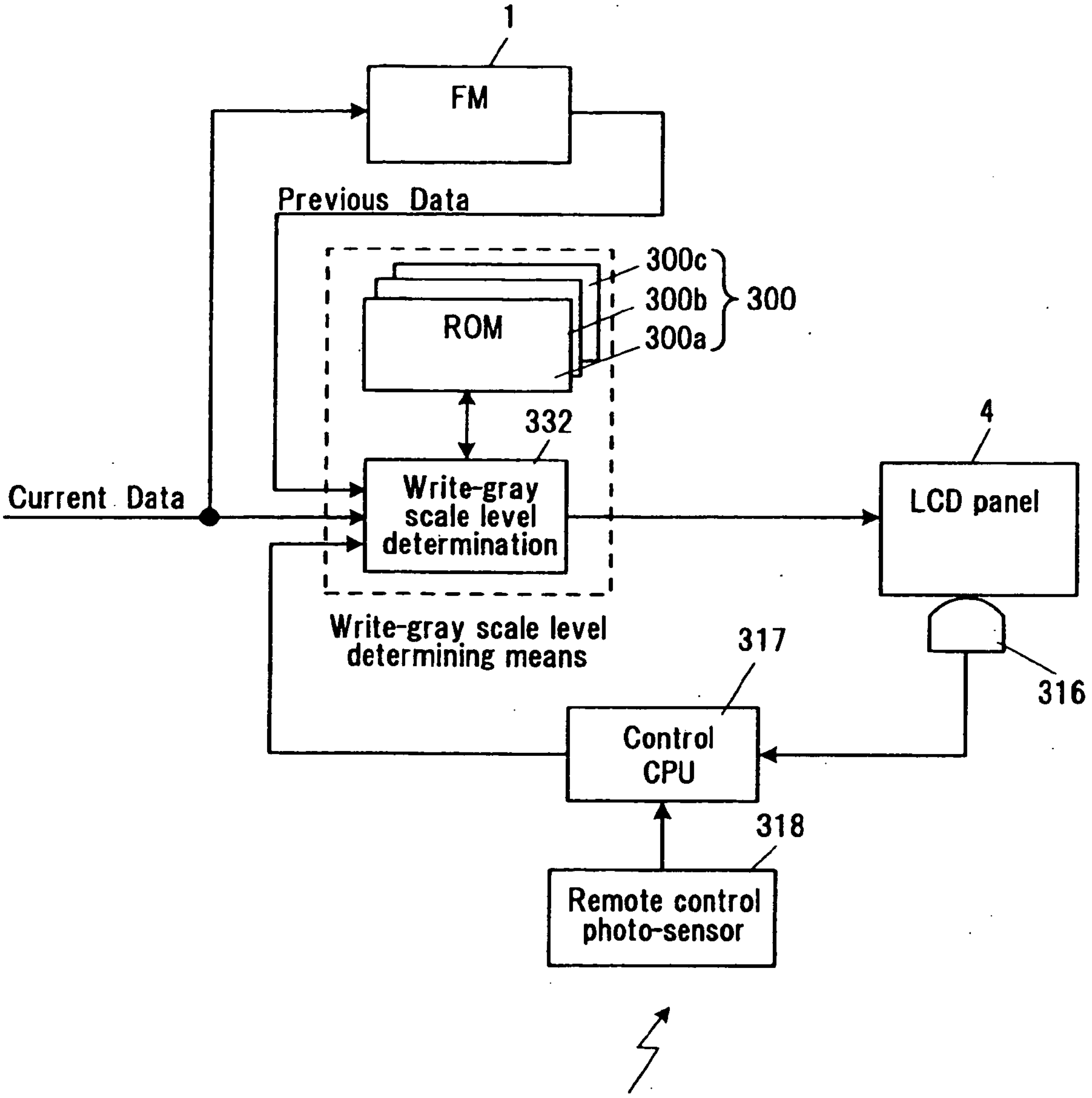

1
FM
Previous Data
300c
300b
300a
300
ROM
332
Current Data
Write-gray scale level determination
Write-gray scale level determining means
4
LCD panel
316
317
Control CPU
318
Remote control photo-sensor

FIG. 50

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	32	64	96	128	160	192	224	255
32	0	32	64	96	128	160	192	224	255
64	0	32	64	96	128	160	192	224	255
96	0	32	64	96	128	160	192	224	255
128	0	32	64	96	128	160	192	224	255
160	0	32	64	96	128	160	192	224	255
192	0	32	64	96	128	160	192	224	255
224	0	32	64	96	128	160	192	224	255
255	0	32	64	96	128	160	192	224	255

Table content in ROM 300c

FIG. 51

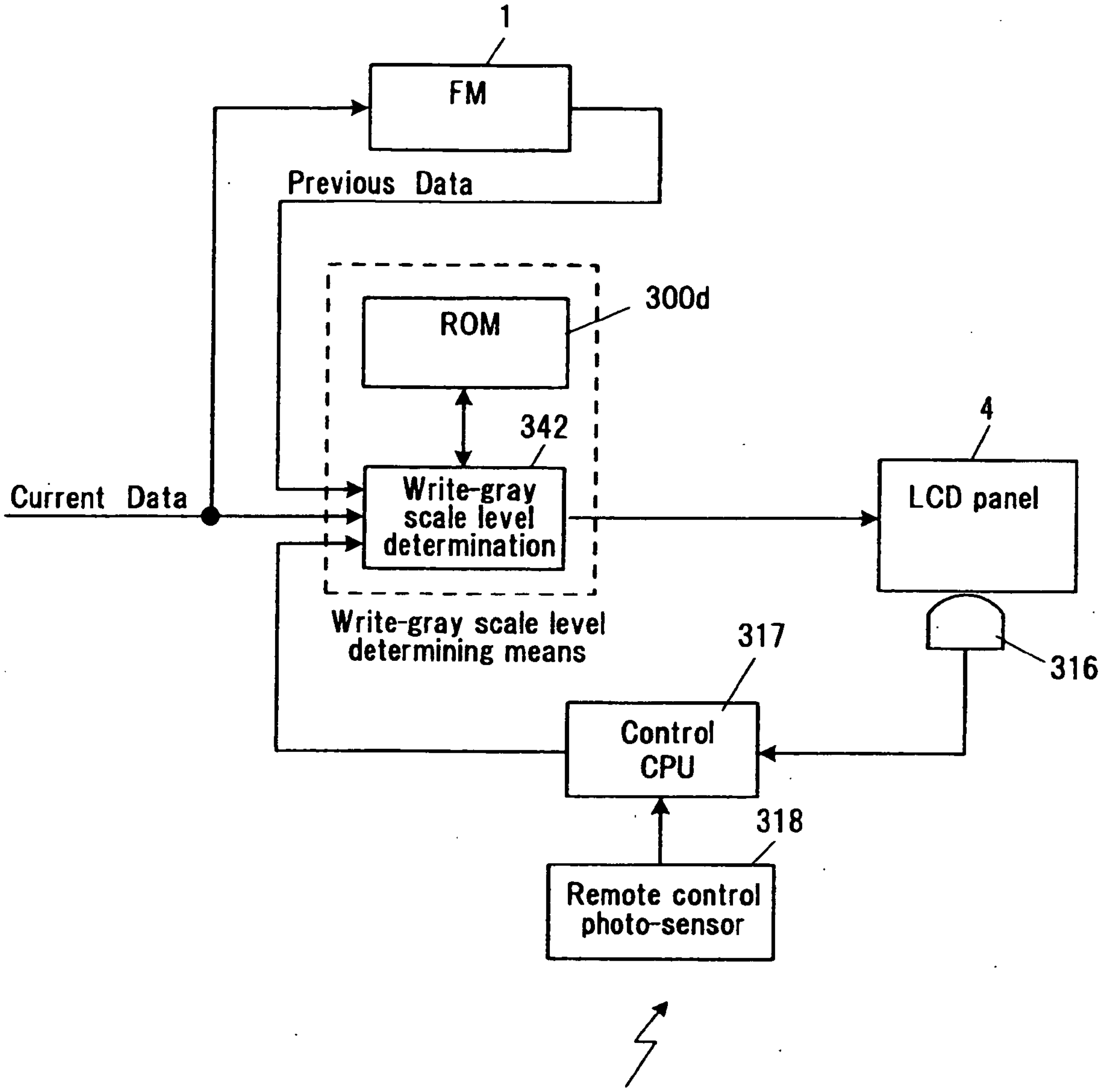

1
FM
Previous Data
300d
ROM
342
Write-gray scale level determination
Write-gray scale level determining means
Current Data
4
LCD panel
316
317
Control CPU
318
Remote control photo-sensor

FIG. 52

Current frame data

Previous frame data

		0	32	64	96	128	160	192	224	225
LEVEL 0	0									
	32									
	64									
	96									
	128									
	160									
	192									
	224									
	255									
LEVEL 1	0									
	• • •									
	255									
LEVEL 2	0									
	• • •									
	255									

Table content in ROM 300d

FIG. 53

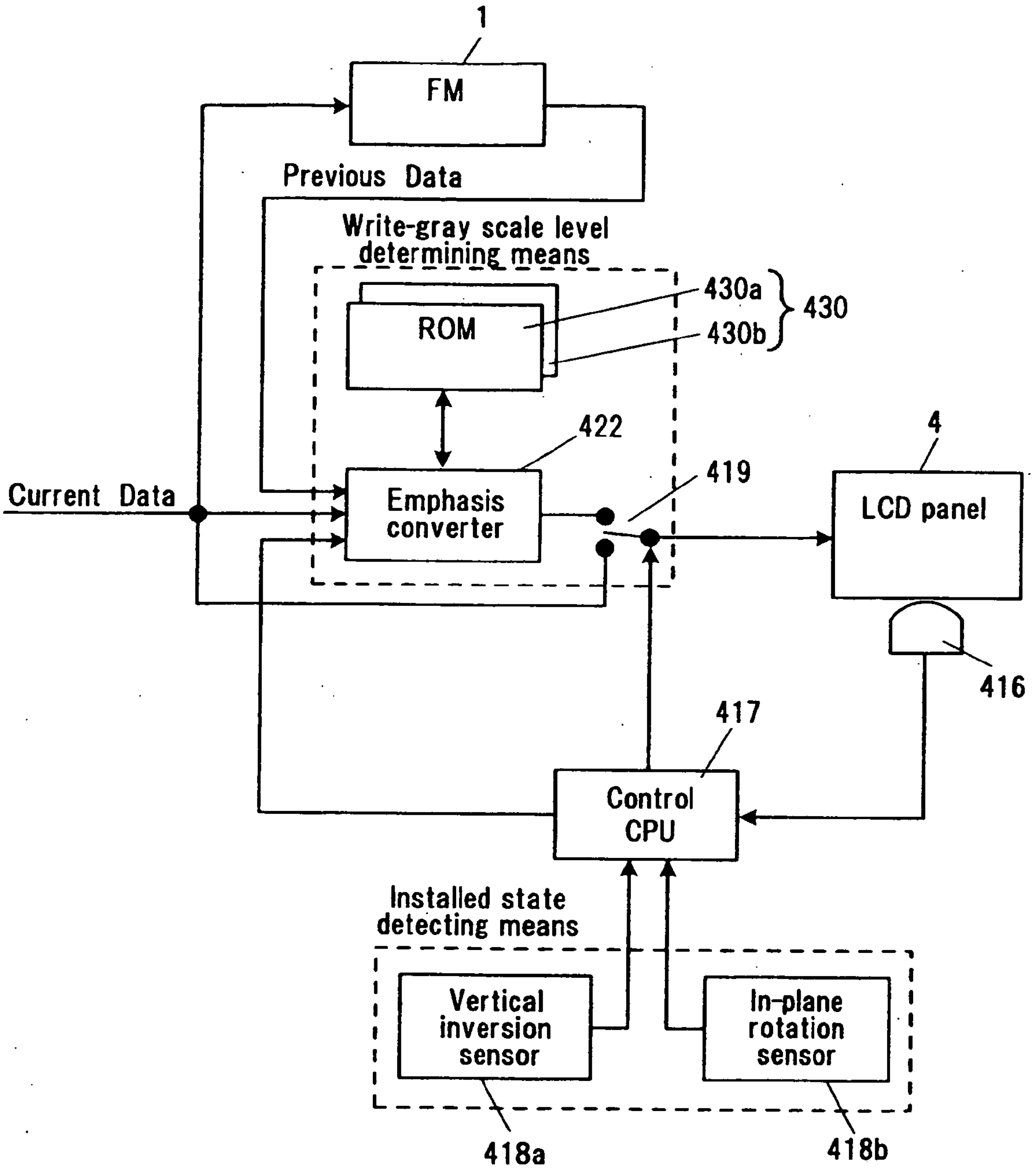

1
FM
Previous Data
Write-gray scale level determining means
ROM
430a
430b
430
422
Emphasis converter
419
4
LCD panel
Current Data
416
417
Control CPU
Installed state detecting means
Vertical inversion sensor
In-plane rotation sensor
418a
418b

FIG. 54

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	51	118	165	194	214	230	242	255
32	0	32	120	159	183	206	226	240	255
64	0	12	64	110	150	182	209	234	255
96	0	0	48	96	140	175	204	232	255
128	0	0	43	81	128	167	201	232	255
160	0	0	35	66	117	160	196	229	255
192	0	0	2	56	105	152	192	227	255
224	0	0	0	50	85	139	186	224	255
255	0	0	0	44	75	136	181	215	255

(a) Table content in ROM 430b

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	70	147	182	206	227	241	255	255
32	0	32	94	142	177	202	224	239	255
64	0	0	64	116	157	193	218	241	255
96	0	0	31	96	141	177	209	234	255
128	0	0	18	71	128	169	203	232	255
160	0	0	0	53	111	160	199	230	255
192	0	0	0	29	92	148	192	228	255
224	0	0	0	13	55	133	183	224	255
255	0	0	0	0	48	117	173	220	255

(b) Table content in ROM 430a

FIG. 55

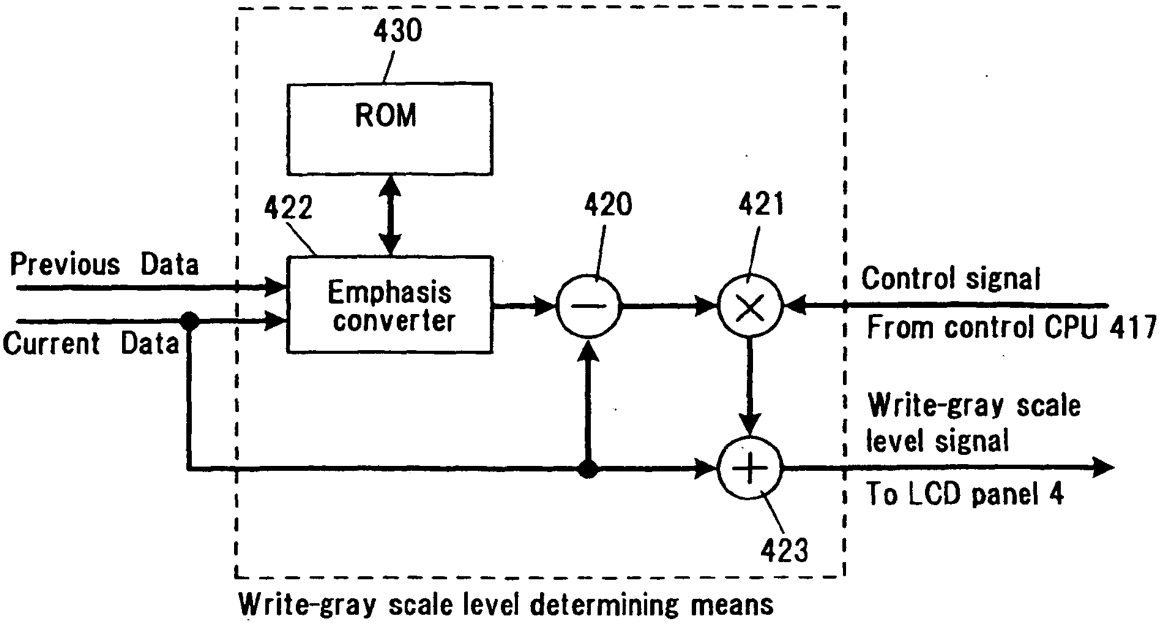

430
ROM
422
Previous Data
Current Data
Emphasis converter
420
421
Control signal
From control CPU 417
Write-gray scale level signal
To LCD panel 4
423
Write-gray scale level determining means

FIG. 56

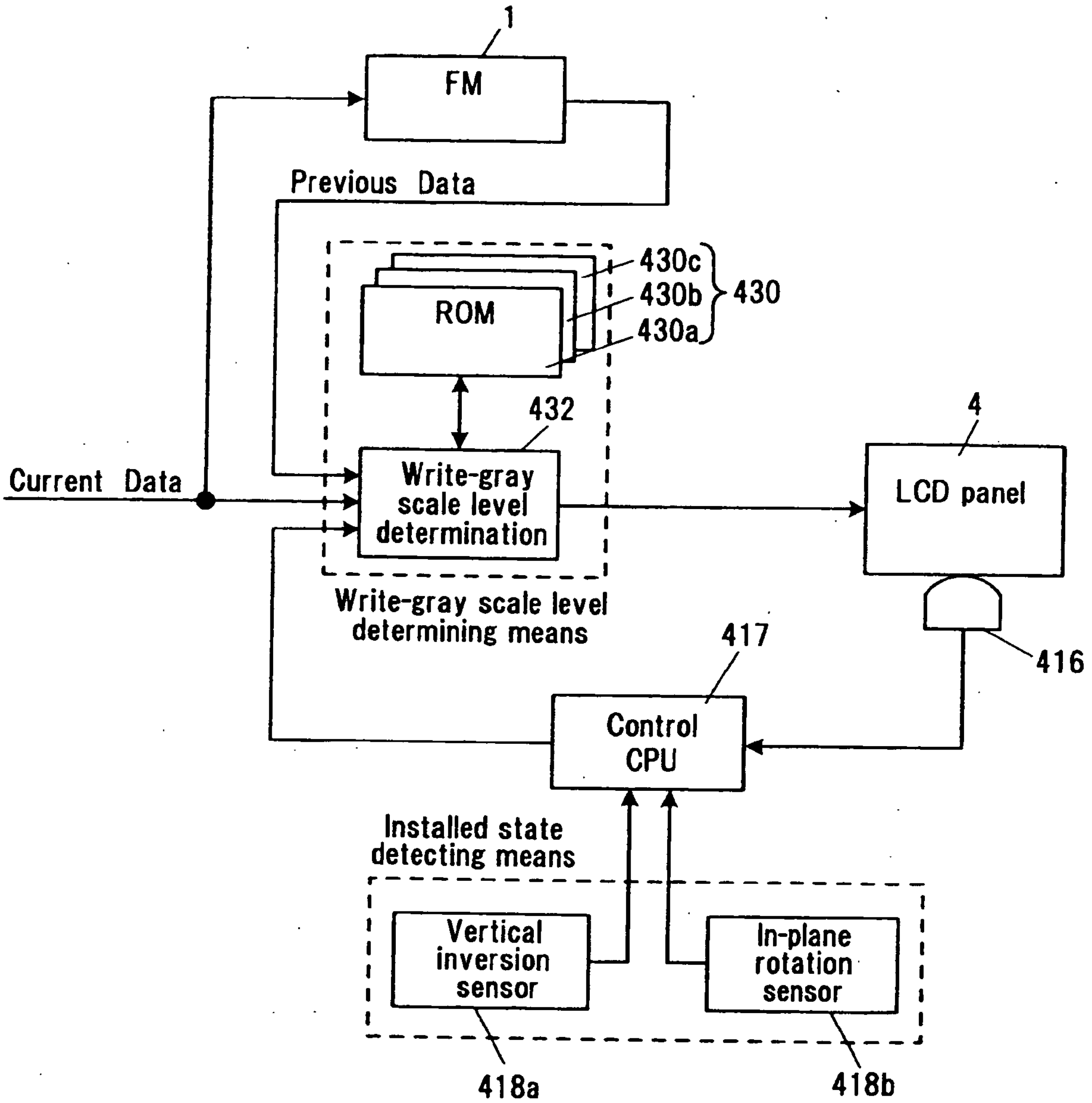

1
FM
Previous Data
430c
430b
430a
430
ROM
432
Current Data
Write-gray scale level determination
Write-gray scale level determining means
4
LCD panel
416
417
Control CPU
Installed state detecting means
Vertical inversion sensor
In-plane rotation sensor
418a
418b

FIG. 57

Current frame data

Previous frame data

	0	32	64	96	128	160	192	224	255
0	0	32	64	96	128	160	192	224	255
32	0	32	64	96	128	160	192	224	255
64	0	32	64	96	128	160	192	224	255
96	0	32	64	96	128	160	192	224	255
128	0	32	64	96	128	160	192	224	255
160	0	32	64	96	128	160	192	224	255
192	0	32	64	96	128	160	192	224	255
224	0	32	64	96	128	160	192	224	255
255	0	32	64	96	128	160	192	224	255

Table content in ROM 430c

FIG. 58

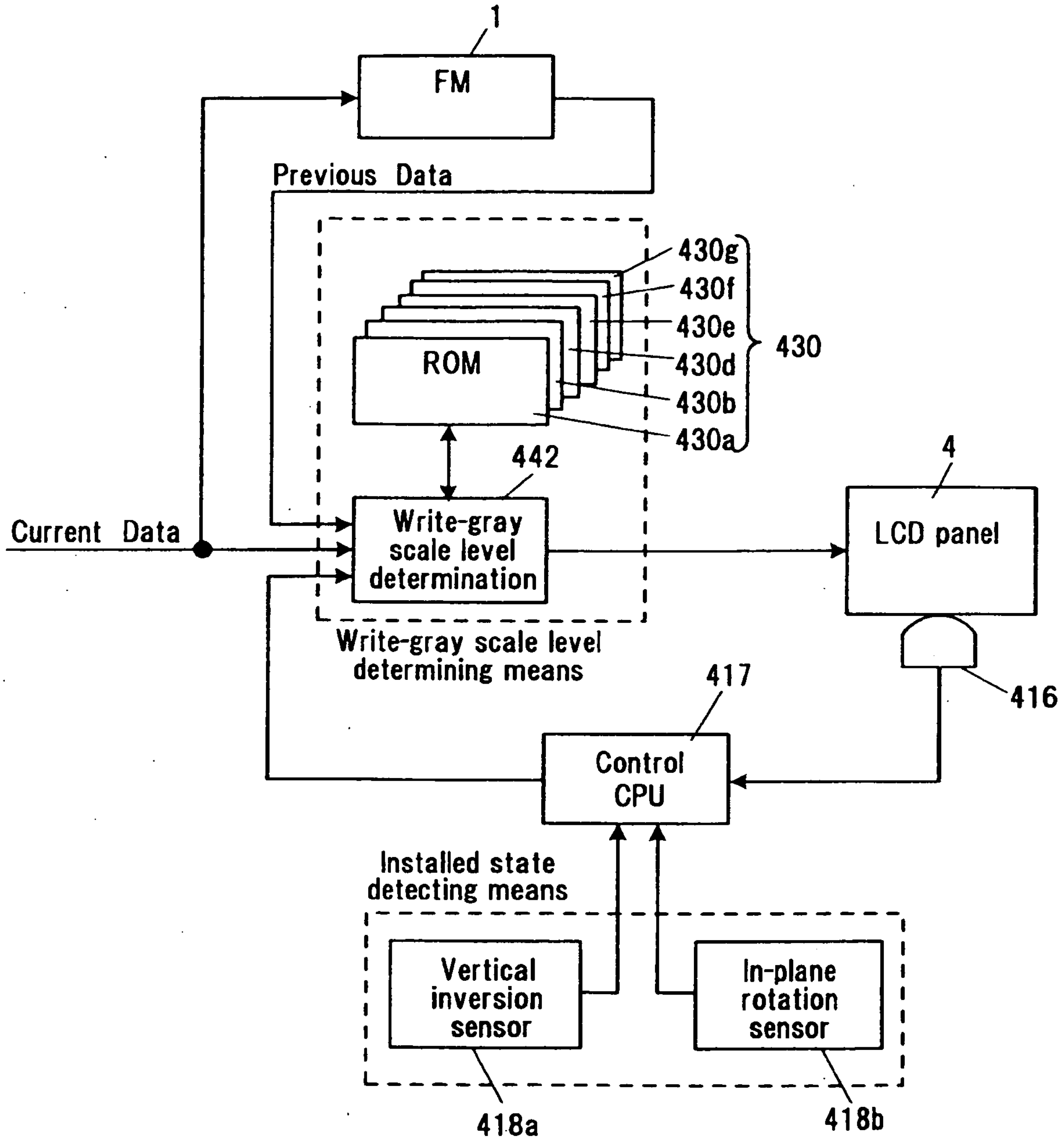

1
FM
Previous Data
430g
430f
430e
430d
430b
430a
430
ROM
442
4
Current Data
Write-gray scale level determination
LCD panel
Write-gray scale level determining means
417
416
Control CPU
Installed state detecting means
Vertical inversion sensor
In-plane rotation sensor
418a
418b

FIG. 59

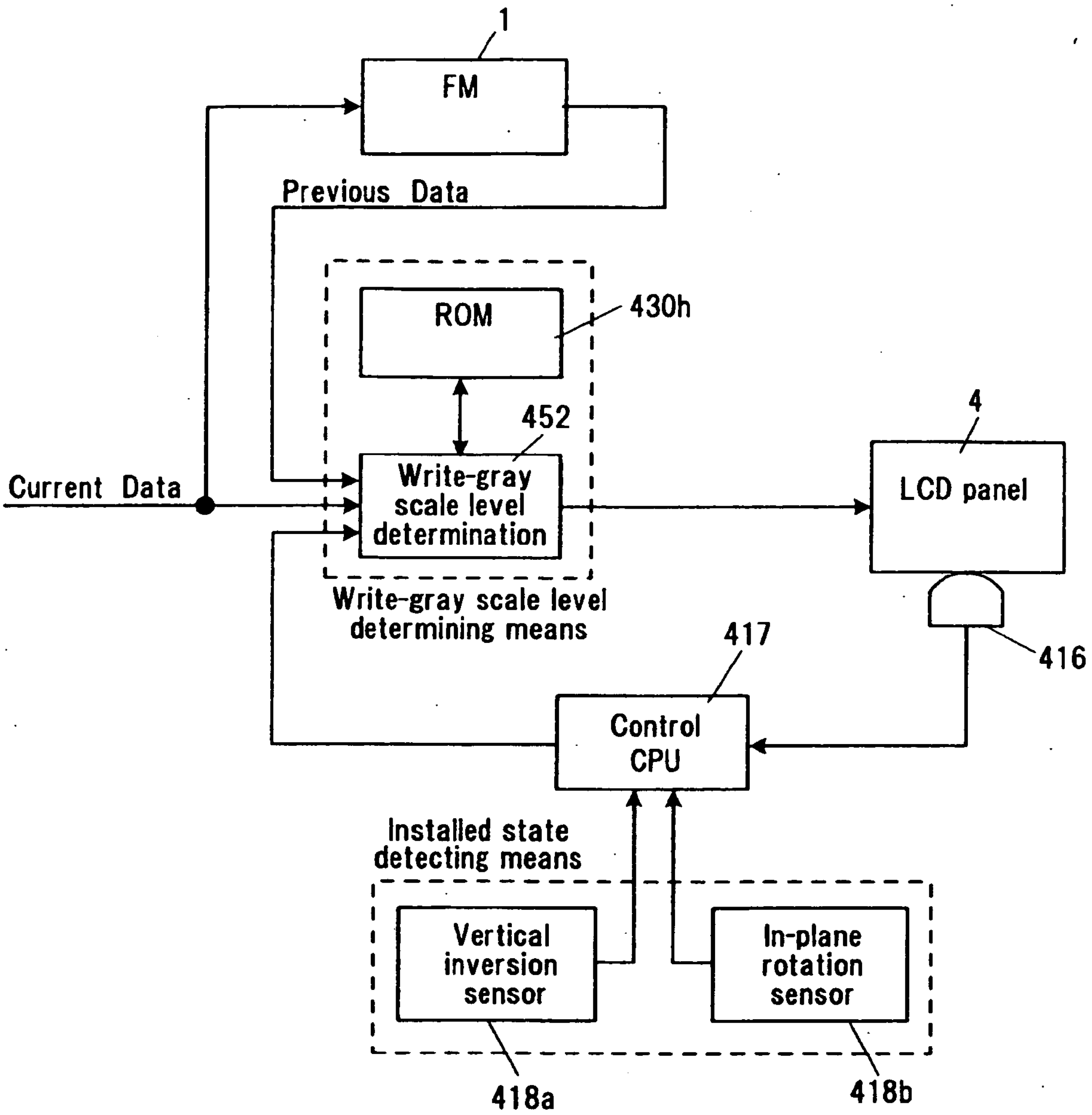

1
FM
Previous Data
ROM
430h
452
Current Data
Write-gray scale level determination
Write-gray scale level determining means
4
LCD panel
416
417
Control CPU
Installed state detecting means
Vertical inversion sensor
In-plane rotation sensor
418a
418b

FIG. 60

			Current frame data								
			0	32	64	96	128	160	192	224	225
Previous frame data	LEVEL 0	0									
		32									
		64									
		96									
		128									
		160									
		192									
		224									
		255									
	LEVEL 1	0									
		• • •									
		255									
	LEVEL 2	0									
		• • •									
		255									

Table content in ROM 430h

FIG. 61

			Current frame data							
		0	32	64	96	128	160	192	224	225
Previous frame data	LEVEL 0	0								
		32								
		64								
		96								
		128								
		160								
		192								
		224								
		255								
	LEVEL 0-1	0								
		• • •								
		255								
	LEVEL 0-2	0								
		• • •								
		255								
	LEVEL 1	0								
		• • •								
		255								
	LEVEL 1-1	0								
		• • •								
		255								
	LEVEL 1- 2	0								
		• • •								
		255								

Table content in ROM 430i

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP HEI396993 B **[0018] [0021]**
- JP HEI4318516 B **[0033]**
- US 5119084 A **[0043]**

专利名称(译)	液晶显示装置		
公开(公告)号	EP1443487B1	公开(公告)日	2012-08-15
申请号	EP2002802739	申请日	2002-11-11
[标]申请(专利权)人(译)	夏普株式会社		
申请(专利权)人(译)	夏普株式会社		
当前申请(专利权)人(译)	夏普株式会社		
[标]发明人	SUGINO MICHIYUKI KIKUCHI YUJI OSADA TOSHIHIKO YOSHII TAKASHI SHIOMI MAKOTO		
发明人	SUGINO, MICHIYUKI KIKUCHI, YUJI OSADA, TOSHIHIKO YOSHII, TAKASHI SHIOMI, MAKOTO		
IPC分类号	G09G3/36 G09G3/20 G02F1/133 H04N5/66 G09G5/00		
CPC分类号	G09G3/3611 G09G2320/02 G09G2320/0252 G09G2340/16		
优先权	2001344078 2001-11-09 JP 2002238956 2002-08-20 JP 2002250201 2002-08-29 JP 2002277488 2002-09-24 JP 2002312265 2002-10-28 JP 2002258826 2002-09-04 JP 2002258827 2002-09-04 JP 2002280964 2002-09-26 JP		
其他公开文献	EP1443487A1 EP1443487A4		
外部链接	Espacenet		

摘要(译)

边缘检测电路通过确定来自相邻像素的像素的差分值是否等于或大于阈值来检测特定像素是否属于边缘。基于检测结果，当像素区域的图像根据边缘检测电路的检测结果被视为边缘图像时，加重转换器停止OS驱动，并且当不考虑像素区域的图像时实现OS驱动作为边缘图像。以这种方式，边缘检测电路检测输入视频的边缘部分，从而可以控制强调转换器中的OS驱动以便接通和断开。

FIG. 1

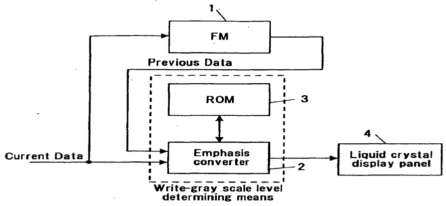
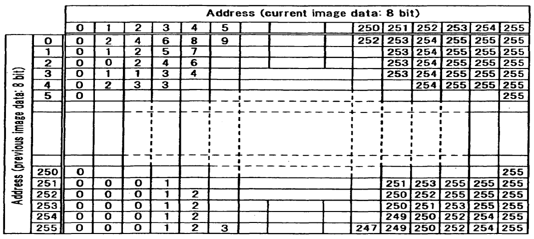


FIG. 2



		Address (current image data: 8 bit)														
		0	1	2	3	4	5				250	251	252	253	254	255
Address (previous image data: 8 bit)	0	0	2	4	6	8	9				252	253	254	255	255	255
	1	0	1	2	5	7						253	254	255	255	255
	2	0	0	2	4	6						253	254	255	255	255
	3	0	1	1	3	4						253	254	255	255	255
	4	0	2	3	3								254	255	255	255
	5	0														255
	250	0														255
	251	0	0	0	1							251	253	255	255	255
	252	0	0	0	1	2						250	252	255	255	255
	253	0	0	0	1	2						250	251	253	255	255
	254	0	0	0	1	2						249	250	252	254	255
	255	0	0	0	1	2	3				247	249	250	252	254	255