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(71) Applicant: **NEC Plasma Display Corporation**
Minato-ku, Tokyo (JP)

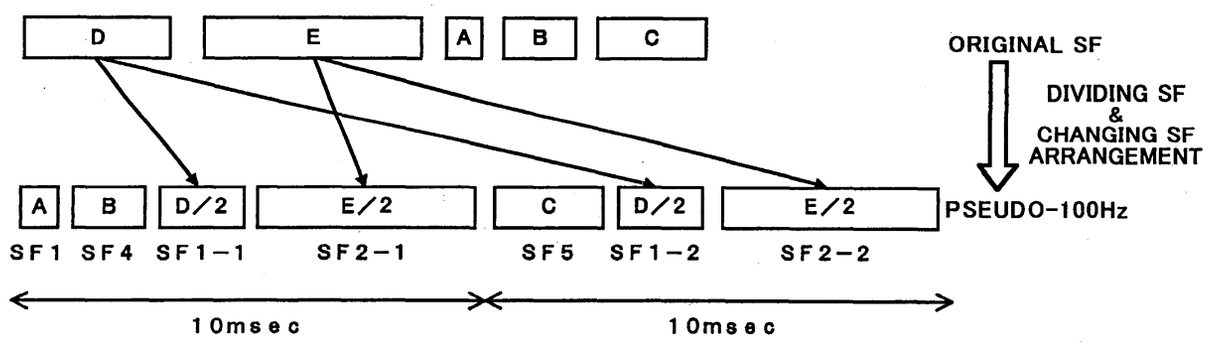
(72) Inventor: **Denda, Kazuo**
c/o Nec Plasma Display Corporation
Minato-ku Tokyo (JP)

(74) Representative: **Glawe. Delfs. Moll**
Patentanwälte
Postfach 26 01 62
80058 München (DE)

(54) Method of displaying images and apparatus for doing the same

(57) A method of displaying images, including the steps of dividing at least one sub-field (SF1, SF2) among a plurality of sub-fields (SF1 to SF5) constituting a field of an image signal, into a plurality of sub-fields (SF1-1, SF1-2; SF2-1, SF2-2) each having a predetermined luminance weight, and pseudo-doubling a field frequency of said image signal, characterized by preferentially selecting a divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2) to a non-divided sub-field (SF3 to SF5) for a gray scale at which images can be displayed with the divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2).

FIG.6



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Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The invention relates to an apparatus for displaying images at a certain gray scale through the use of sub-fields, such as a plasma display unit, and a method of displaying images in such an apparatus, and more particularly to such an apparatus which is capable of reducing big-area flickers generated when a television signal having a relatively low vertical-synchronization frequency or a similar signal is displayed, and a method of displaying images in such an apparatus.

DESCRIPTION OF THE PRIOR ART

[0002] In an apparatus for displaying images only in a binary mode, such as a plasma display unit which displays images by virtue of memory effect, intermediate gray scales are displayed generally in accordance with a sub-field process.

[0003] A sub-field process is a process applicable to an image-displaying apparatus having a high response speed, such as a plasma display unit. In a sub-field process, an image signal is quantized, and resultant one-field data is displayed in time-division for each of gray scale bits.

[0004] Hereinbelow is explained a sub-field process.

[0005] First, a field is divided into a group of small fields each called a sub-field. A weight determined in accordance with the number of light-emissions which number is associated with each of gray scale bits is assigned to each of sub-fields. Images are successively reproduced with the sub-fields, and images over one field are accumulated by virtue of integration effect of visual sense. Thus, there are obtained natural images with intermediate gray scales.

[0006] For instance, in order to display images with 256 gray scales in a sub-field process, input analog image signals are quantized or A/D converted into 8-bit luminance signals associated with gray scale luminance data indicating luminances one of which is twice greater than another.

[0007] Then, data of the quantized image signals is stored in a frame buffer memory. Assuming that a bit having a highest luminance (MSB: Most Significant Bit) is expressed as B1, a bit having a second-highest luminance is expressed as B2, and bits having a N-th highest luminance (N = 3 to 8) are expressed as B3 to B8, a ratio of luminances of the bits is 128: 64: 32: 16: 8: 4: 2: 1. By selecting one of the bits in association with each of pixels, it is possible to display images with 256 gray scales corresponding to 256 luminance levels from 0 to 255.

[0008] As an example of a method of displaying images in accordance with a sub-field process, hereinbelow is explained a method of displaying images, in which a display unit is driven separately in a scanning period and a sustaining period, with reference to FIG. 1. For instance, the method is applied to an AC color plasma display unit.

[0009] As illustrated in FIG. 1, one field is divided into first to eighth sub-fields SF1 to SF8. Each of the sub-fields SF1 to SF8 is comprised of a scanning period A and a sustaining discharge period B. Weights 128, 64, 32, 16, 8, 4, 2 and 1 (figures in parentheses) are assigned to the sub-fields SF1 to SF8, respectively.

[0010] In a scanning period in the first sub-field SF1, data is written into each of pixels, based on display data of the bit B1 having the highest luminance. After data has been written into all of pixels, a sustaining discharge pulse is applied entirely to a display panel to thereby carry out light-emission only in pixels into which data has been written.

[0011] Then, the same steps as mentioned above are carried out for the second to eighth sub-fields SF2 to SF8.

[0012] In a sustaining discharge period in each of the sub-fields, pulses are applied to a display panel 256 times in the first sub-field SF1, for instance, in order to ensure sufficient luminance. Similarly, pulses are applied to a display panel 128, 64, 32, 16, 8, 4 and 2 times in the second to eighth sub-fields SF1 to SF8, respectively.

[0013] An order of sub-fields in the case that a field is designed such that a relative ratio of a luminance is reduced with the lapse of time, as illustrated in FIG. 1, is called a descending sub-field order, and an order of sub-fields in the case that a field is designed such that a relative ratio of a luminance is increased with the lapse of time is called an ascending sub-field, order.

[0014] Apart from those two sub-field orders, sub-fields may be arranged in various ways for displaying gray scales. However, even if sub-fields are arranged simply differently from the above-mentioned two orders, the following problems would be caused.

[0015] A renewal speed of a display screen is generally set identical with a vertical-synchronization signal in a CRT-type display and a plasma display panel. Hence, optical stimulation a viewer receives at his/her eyes from a display screen is recognized as blinking of luminances which are in proportion to vertical-synchronization signals. If a repetition interval of the luminance blinking is long, a viewer could clearly recognize the blinking as flicker, whereas if a repetition interval of the luminance blinking is short, a viewer would recognize the blinking as continuous light-emission. A boundary interval between the former and latter intervals is called a critical fusion interval.

[0016] A vertical synchronization frequency adapted in European TV standards is generally 50 Hz, and a repetition period of a vertical synchronization signal and a repetition period of an image signal are designed equal to 20 ms, which is almost equal to the above-mentioned

critical fusion period.

[0017] Whether a viewer recognizes blinking of luminances as flickers or as continuous light-emission is dependent on a luminance level of a displayed image signal. Even if the same image is displayed, a viewer is more likely to recognize blinking of luminances as flickers, if a displayed image signal had a higher luminance level. Among flickers, flickers observed in an entire display screen, caused by a low vertical-synchronization frequency, are in particular called big area flickers. Big-area flickers reduce display quality in particular when signals having a high luminance level are displayed.

[0018] As a solution to such big-area flickers, technique called "100 Hz TV" is recently frequently used in a CRT-type television set. In "100 Hz TV", a vertical frequency is doubled on a side of a receiver, and further, image data for one image plane is stored in a memory, and the data stored in a memory is read out twice at a doubled speed. The technique "100 Hz TV" reduces big-area flickers to a level a viewer can scarcely detect flickers.

[0019] In contrast, a method called "pseudo-100 Hz" is used in a plasma display panel. In the method, some of upper grade sub-fields are divided into a plurality of sub-fields, and the thus divided sub-fields are arranged in such a manner that a frequency of 50 Hz of an image signal is increased up to 100 Hz, thereby reducing big-area flickers.

[0020] However, reduction in big-area flickers by the above-mentioned "pseudo-100 Hz" is not accomplished unless the divided sub-fields are turned on.

[0021] For instance, Japanese Patent Application Publication No. 2001-42818 has suggested an example of an arrangement of divided sub-fields.

[0022] However, the Publication merely discloses an arrangement of divided sub-fields, but does not mention an order in which divided sub-fields are displayed or turned on.

[0023] Japanese Patent Application Publication No. 11-15435 has suggested an order in which sub-fields each having a weight are displayed.

[0024] Hereinbelow is explained the suggested order in which sub-fields are displayed.

[0025] As illustrated in FIG. 2, a field is divided into five sub-fields SF1 to SF5. Weights 1, 2, 3, 4 and 6 (figures in parentheses) are assigned to the sub-fields SF1 to SF5, respectively. That is, the sub-fields SF1 to SF5 are arranged in an order of a magnitude of weights.

[0026] FIG. 3 is a table showing which sub-field or sub-fields is(are) turned on among the five sub-fields SF1 to SF5.

[0027] For instance, the first sub-field SF1 having a weight of 1 and the second sub-field SF2 having a weight of 2 are turned on for a gray scale of 3. For a gray scale of 9, the second sub-field SF2 having a weight of 2, the third sub-field SF3 having a weight of 3, and the fourth sub-field SF4 having a weight of 4 are turned on.

[0028] A method of displaying sub-fields, disclosed in Japanese Patent Application Publication No. 11-15435, includes the steps of assigning smaller numbers to sub-fields having a smaller weight, as illustrated in FIG. 2, and selecting a combination of sub-fields to be displayed at each of gray scales such that a sub-field or sub-fields having a smaller number or weight is(are) preferentially turned on, as illustrated in FIG. 3.

[0029] The method has a principal object of suppressing moving picture pseudo-frame, and suppressing flickers is a second object.

[0030] The sub-fields in the method disclosed in Japanese Patent Application Publication No. 11-15435 are not divided sub-fields. Hence, it is assumed that the method of displaying divided sub-fields is applied to the method of displaying sub-fields, suggested in the above-mentioned Japanese Patent Application Publication No. 2001-42818.

[0031] For instance, it is assumed that among the five sub-fields SF1 to SF5 illustrated in FIG. 2, the fourth and fifth sub-fields SF4 and SF5 are divided sub-fields having weights 4 and 6, respectively.

[0032] Under the assumption, if the sub-fields are turned on in accordance with the light-emission order illustrated in FIG. 3, the divided sub-field or sub-fields is (are) not turned on at certain gray scales, though the divided sub-field or sub-fields can be turned on.

[0033] For instance, the fourth sub-field SF4 can be turned on at a gray scale of 4. However, the first and third sub-fields SF1 and SF3 having weights 1 and 3, respectively, are actually turned on.

[0034] The fact that the divided sub-field is not turned on at a certain gray scale causes that the number of gray scales at which image signals having a pseudo-100 Hz frequency are displayed is reduced, resulting in that it would be impossible to sufficiently reduce flickers by virtue of the pseudo-100 Hz technique.

[0035] This is because that the method suggested in Japanese Patent Application Publication No. 11-15435, in which a sub-field is not divided, that is, the method of preferentially displaying a sub-field having a smaller weight for suppressing moving picture pseudo-frame is applied without any modification to the pseudo-100 Hz technique in which it is absolutely necessary to divide a sub-field into a plurality of sub-fields.

SUMMARY OF THE INVENTION

[0036] In view of the above-mentioned problems in the prior art, it is an object of the present invention to provide a method of displaying images which is capable of efficiently reducing big-area flickers when an image signal having a problem of big-area flickers is caused to have a pseudo-100 Hz by dividing a sub-field having a great weight into a plurality of sub-fields.

[0037] It is also an object of the present invention to provide an apparatus for displaying images which is capable of doing the same.

[0038] In one aspect of the present invention, there is

provided a method of displaying images, including the steps of dividing at least one sub-field among a plurality of sub-fields constituting a field of an image signal, into a plurality of sub-fields each having a predetermined luminance weight, and pseudo-doubling a field frequency of the image signal, characterized by preferentially selecting a divided sub-field to a non-divided sub-field for a gray scale at which images can be displayed with the divided sub-field.

[0039] It is preferable that the divided sub-field is selected preferentially to a non-divided sub-field for the gray scale when the field frequency is smaller than 60 Hz.

[0040] An order of displaying the sub-fields when the field frequency is equal to or greater than 60 Hz may be different from an order of displaying the sub-fields when the field frequency is smaller than 60 Hz.

[0041] It is preferable that the non-divided sub-field is selected preferentially to the divided sub-field when the field frequency is equal to or greater than 60 Hz, and the divided sub-field is selected preferentially to the non-divided sub-field for the gray scale when the field frequency is smaller than 60 Hz.

[0042] It is preferable that the divided sub-fields are arranged in an order of a magnitude of the luminance weight.

[0043] It is preferable that the non-divided sub-fields are arranged in an order of a magnitude of the luminance weight.

[0044] For instance, the method may be applied to a method of displaying images in a plasma display unit.

[0045] In another aspect of the present invention, there is provided an apparatus for displaying images, which divides at least one sub-field among a plurality of sub-fields constituting a field of an image signal, into a plurality of sub-fields each having a predetermined luminance weight, and pseudo-doubles a field frequency of the image signal, characterized in that a divided sub-field is preferentially selected to a non-divided sub-field for a gray scale at which images can be displayed with the divided sub-field.

[0046] It is preferable that the divided sub-field is selected preferentially to a non-divided sub-field for the gray scale when the field frequency is smaller than 60 Hz.

[0047] An order of displaying the sub-fields when the field frequency is equal to or greater than 60 Hz may be different from an order of displaying the sub-fields when the field frequency is smaller than 60 Hz.

[0048] It is preferable that the non-divided sub-field is selected preferentially to the divided sub-field when the field frequency is equal to or greater than 60 Hz, and the divided sub-field is selected preferentially to the non-divided sub-field for the gray scale when the field frequency is smaller than 60 Hz.

[0049] It is preferable that the divided sub-fields are arranged in an order of a magnitude of the luminance weight.

[0050] It is preferable that the non-divided sub-fields are arranged in an order of a magnitude of the luminance weight.

[0051] For instance, the apparatus is comprised of a plasma display unit.

[0052] The advantages obtained by the aforementioned present invention will be described hereinbelow.

[0053] In accordance with the present invention, since divided sub-field or sub-fields is(are) displayed preferentially to non-divided sub-field or sub-fields, it would be possible to increase the number of divided sub-fields displayed. In other words, it would be possible to increase the number of gray scales at which image signals having a pseudo-100 Hz frequency are displayed, relative to a total number of gray scales, and hence, it would be possible to reduce a ratio of gray scales at which flickers are generated, to a total number of grays scales. Thus, flickers can be certainly reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0054]

FIG. 1 illustrates an example of sub-field arrangement in a conventional plasma display unit.

FIG. 2 illustrates an example of sub-field arrangement in a conventional apparatus for displaying images.

FIG. 3 is a table showing an order of displaying sub-fields in a conventional apparatus for displaying images.

FIG. 4 is a block diagram of an apparatus for displaying images, in accordance with a preferred embodiment of the present invention.

FIG. 5 illustrates an example of sub-field arrangement in the apparatus in accordance with a preferred embodiment of the present invention.

FIG. 6 illustrates an example of sub-field arrangement including divided sub-field or sub-fields in the apparatus in accordance with a preferred embodiment of the present invention.

FIG. 7 is a table showing which sub-field is to be turned on in the apparatus in accordance with a preferred embodiment of the present invention.

FIG. 8 is a table showing comparison between an order of displaying sub-fields in a conventional apparatus for displaying images and an order of displaying sub-fields in the apparatus in accordance with a preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0055] FIG. 4 is a block diagram of an apparatus 10 for displaying images, in accordance with a preferred embodiment of the present invention.

[0056] The apparatus 10 is comprised of an analog-

digital (A/D) converter 21, a reverse-gamma (y) compensator 22, a first data-arranger 23, a central processing unit (CPU) 24, a frame buffer memory 25, a second data-arranger 26, a first data-driver 27, a second data-driver 28, a synchronization separator 29, a system clock generator 30, a sub-field generator 31, a timing generator 32, a scanning driver 33, and a plasma display panel (PDP) 34.

[0057] The A/D converter 21 receives RGB image signals, and quantizes them.

[0058] The images signals quantized by the A/D converter 21 are compensated for by the reverse-gamma compensator 22 with respect to brightness data.

[0059] Data signals output from the reverse-gamma compensator 22 are arranged in the first data-arranger 23 such that the data signals are suitable for being stored in the frame buffer memory 25. Specifically, the RGB image signals are mixed with one another to obtain addresses different for each of gray scale bits.

[0060] The central processing unit 24 carries out read/write control between the frame buffer memory 25 and a previous or next stage.

[0061] Data indicative of each of gray scale bits of images read out for each of sub-fields is transmitted to the second data-arranger 26 through the central processing unit 24. Then, the data is rearranged into a final arrangement, and then, transmitted to the first and second data-drivers 27 and 28.

[0062] The synchronization separator 29 separates synchronization signals out of the RGB image signals.

[0063] The system clock generator 30 outputs a system clock.

[0064] Vertical-synchronization signals among the synchronization signals separated out of the RGB image signals in the synchronization separator 29 are transmitted to the sub-field generator 31, and are used as reference signals for a sub-field sequence. The sub-field generator 31 determines an order of arranging sub-fields, based on both the system clock transmitted from the system clock generator 30 and the vertical-synchronization signals.

[0065] The timing generator 32 receives output signals transmitted from the sub-field generator 31, and transmits a timing signal to the central processing unit 24 and the scanning driver 33.

[0066] The scanning driver 33 drives scanning electrodes formed on the plasma display panel 34, in accordance with the timing signals received from the timing generator 32.

[0067] Scanning pulses are applied to scanning electrodes one by one, and a data pulse is applied to a selected data electrode in synchronization with application of the scanning pulse. After the linear scanning has been effected all over a panel, sustaining discharge is effected entirely over the panel, resulting in emission of color light.

[0068] FIG. 5 shows an arrangement of sub-fields generated in the apparatus 10.

[0069] As illustrated in FIG. 5, the sub-field generator 31 generates first to fifth sub-fields SF1 to SF5 all of which constitutes one field. Weights 4, 6, 1, 2 and 3 (figures in parentheses) are assigned to the sub-fields SF1 to SF5, respectively.

[0070] In the embodiment, among the first to fifth sub-fields SF1 to SF5, each of the first and second sub-fields SF1 and SF2 is divided into two sub-fields.

[0071] In the embodiment, the sub-fields SF1 and SF2 to be divided into a plurality of sub-fields are arranged in advance of sub-fields SF3 to SF5 not to be divided into a plurality of sub-fields. Furthermore, a sub-field having a smaller weight is arranged in advance of a sub-field having a higher weight among both sub-fields to be divided into a plurality of sub-fields and both sub-fields not to be divided.

[0072] Specifically, the first SF1 having a weight of 4 is first arranged, and the second sub-field SF2 having a weight of 6 is second arranged among sub-fields to be divided into a plurality of sub-fields. Among sub-fields not to be divided, the third sub-field SF3 having a weight of 1 is first arranged, the fourth sub-field SF 4 having a weight of 2 is second arranged, and the fifth sub-field SF5 having a weight of 3 is third arranged.

[0073] By arranging the sub-fields in the above-mentioned manner, it is possible to suppress moving picture pseudo-frame to some degree.

[0074] FIG. 6 illustrates an example of the sub-field arrangement including the first and second sub-fields SF1 and SF2 divided into two sub-fields.

[0075] When image signals having a field frequency of 50 Hz are displayed like PAL (Phase Alternation by Line) in the pseudo-100 Hz technique, a plurality of sub-fields each having a high weight is divided into a plurality of sub-fields, and the divided sub-fields are arranged to appear every about 10 msec interval in a field time (20 msec).

[0076] Hence, in the embodiment, as illustrated in FIG. 6, the first sub-field SF1 is divided into two sub-fields SF1-1 and SF1-2, and the second sub-field SF2 is divided into two sub-fields SF2-1 and SF2-2. A weight of 2, which means a half of the weight 4 of the first sub-field SF1, is assigned to each of the sub-fields SF1-1 and SF1-2. Similarly, a weight of 3, which means a half of the weight 6 of the second sub-field SF2, is assigned to each of the sub-fields SF2-1 and SF2-2.

[0077] In addition, the third sub-field SF3, the fourth sub-field SF4, the divided sub-field SF1-1 and the divided sub-field SF2-1 are arranged in this order in the first 10 msec, and the fifth sub-field SF5, the divided sub-field SF1-2 and the divided sub-field SF2-2 are arranged in this order in the second 10 msec.

[0078] Thus, in each of the first and second 10 msecs, the divided sub-fields are arranged behind the non-divided sub-fields.

[0079] FIG. 7 is a table showing which sub-field or sub-fields is(are) to be turned on among the first to fifth sub-fields SF1 to SF5 in association with each of gray

scales in the apparatus 10 in accordance with the embodiment.

[0080] In the embodiment, the divided sub-field SF1-1, SF1-2, SF2-1 or SF2-2 is displayed preferentially to the non-divided sub-field SF3, SF4 and SF5 for a gray scale in which the divided sub-field SF1-1, SF1-2, SF2-1 or SF2-2 can be displayed.

[0081] For instance, when the gray scale number is equal to 4, though the third sub-field SF3 having a weight of 1 and the fifth sub-field SF5 having a weight of 3 may be displayed, the first sub-field SF1 having a weight of 4, that is, the divided sub-field SF1-1 having a weight of 2 and the divided sub-field SF1-2 having a weight of 2 are displayed in the embodiment in place of the third and fifth sub-fields SF3 and SF5.

[0082] Similarly, when the gray scale number is equal to 6, though the third sub-field SF3 having a weight of 1, the fourth sub-field SF4 having a weight of 2 and the fifth sub-field SF5 having a weight of 3 may be displayed, the first sub-field SF1 having a weight of 4, that is, the divided sub-field SF1-1 having a weight of 2 and the divided sub-field SF1-2 having a weight of 2, and the fourth sub-field SF4 having a weight of 2 are displayed in the embodiment in place of the third, fourth and fifth sub-fields SF3, SF4 and SF5.

[0083] The above-mentioned order of displaying the sub-fields is determined by the central processing unit 24.

[0084] As explained above, in the apparatus 10 in accordance with the embodiment, a smaller number is assigned to divided sub-fields, and a combination of sub-fields is selected for each of gray scales so as to allow a sub-field having a smaller number to be displayed preferentially to other sub-fields having a higher number. Accordingly, as explained in the above-mentioned examples where the gray scale numbers are 4 and 6, the divided sub-fields are absolutely turned on for a gray scale in which the divided sub-field or sub-fields can be turned on.

[0085] In the sub-field arrangement illustrated in FIG. 6, it is necessary for the divided sub-fields to be turned on in order to accomplish a pseudo-100 Hz display. In accordance with the apparatus 10, the divided sub-field or sub-fields is(are) displayed preferentially to the non-divided sub-fields, ensuring that the number of gray scales at which pseudo-100 Hz display is accomplished can be increased in comparison with the conventional apparatus. This means that a ratio of gray scales at which flickers are generated to the total number of gray scales can be reduced, and hence, flickers can be reduced.

[0086] FIG. 8 is a table showing both sub-fields to be displayed in the apparatus 10 for each of gray scales 1 to 16 and sub-fields to be displayed in the conventional apparatus illustrated in FIG. 3.

[0087] In FIG. 8, a circle (○) indicates a sub-field to be displayed in the conventional apparatus illustrated in FIG. 3, and a triangle (△) indicates a sub-field to be displayed in the apparatus 10.

[0088] As is obvious in view of FIG. 8, there are no gray scales at which the divided sub-field or sub-fields is(are) displayed in the conventional apparatus, but is(are) not displayed in the apparatus 10.

[0089] In contrast, there are six gray scales at which the divided sub-field or sub-fields is(are) displayed in the apparatus 10, but is(are) not displayed in the conventional apparatus illustrated in FIG. 3. Such gray scales are indicated with a double circle (◎) at the rightmost column. Among the gray scales 1 to 16, the divided sub-field or sub-fields is(are) displayed in the apparatus 10, but is(are) not displayed in the conventional apparatus illustrated in FIG. 3, at gray scales 4, 5, 6, 10, 11 and 12.

[0090] In accordance with the apparatus 10, the divided sub-field or sub-fields is(are) displayed preferentially to the non-divided sub-fields, and hence, the number of the divided sub-fields to be displayed can be increased. Hence, the number of gray scales at which pseudo-100 Hz display is accomplished can be increased, and thus, a ratio of gray scales at which flickers are generated to the total number of gray scales can be reduced. Accordingly, flickers can be reduced.

[0091] Various methods of displaying images can be derived from the method of displaying images, carried out in the apparatus 10 in accordance with the embodiment. Hereinbelow are explained examples of a method of displaying images, to which the method is applied.

[0092] It is known that when a field frequency is equal to or greater than 60 Hz, flickers can be scarcely detected by a viewer, but when a field frequency is smaller than 60 Hz, flickers are readily detected by a viewer, as taught in Japanese Patent Application Publication No. 2002-32054.

[0093] Hence, the above-mentioned method to be carried out in the apparatus 10 may be carried out only when a field frequency is smaller than 60 Hz, in which case, as a method of displaying a sub-field to be carried out when a field frequency is equal to or greater than 60 Hz, any method may be selected. For instance, sub-fields may be turned on in a descending order of a weight. As an alternative, when some of sub-fields having a high weight is divided, non-divided sub-field or sub-fields may be displayed preferentially to divided sub-field or sub-fields.

[0094] An order of displaying sub-fields when a field frequency is equal to or greater than 60 Hz may be different from an order of displaying sub-fields when a field frequency is smaller than 60 Hz, in which case, there may be selected an order of displaying sub-fields where divided sub-field or sub-fields are displayed preferentially to non-divided sub-field or sub-fields like the above-mentioned embodiment, as an order of displaying sub-fields when a field frequency is smaller than 60 Hz.

[0095] The apparatus 10 in accordance with the above-mentioned embodiment may be applied to all apparatuses which display images through a sub-field

process. For instance, the apparatus 10 in accordance with the above-mentioned embodiment may be applied to a plasma display panel (PDP), a digital micro-mirror device (DMD) or an organic electroluminescence device.

Claims

1. A method of displaying images, including the steps of dividing at least one sub-field (SF1, SF2) among a plurality of sub-fields (SF1 to SF5) constituting a field of an image signal, into a plurality of sub-fields (SF1-1, SF1-2; SF2-1, SF2-2) each having a predetermined luminance weight, and pseudo-doubling a field frequency of the image signal,

   characterized by preferentially selecting a divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2) to a non-divided sub-field (SF3 to SF5) for a gray scale at which images can be displayed with the divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2).

2. The method as set forth in claim 1, wherein the divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2) is selected preferentially to a non-divided sub-field (SF3 to SF5) for the gray scale when the field frequency is smaller than 60 Hz.

3. The method as set forth in claim 1, wherein an order of displaying the sub-fields when the field frequency is equal to or greater than 60 Hz is different from an order of displaying the sub-fields when the field frequency is smaller than 60 Hz.

4. The method as set forth in claim 3, wherein the non-divided sub-field (SF3 to SF5) is selected preferentially to the divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2) when the field frequency is equal to or greater than 60 Hz, and the divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2) is selected preferentially to the non-divided sub-field (SF3 to SF5) for the gray scale when the field frequency is smaller than 60 Hz.

5. The method as set forth in claim 1, 2, 3 or 4, wherein the divided sub-fields (SF1-1, SF1-2; SF2-1, SF2-2) are arranged in an order of a magnitude of the luminance weight.

6. The method as set forth in claim 1, 2, 3 or 4, wherein the non-divided sub-fields (SF3 to SF5) are arranged in an order of a magnitude of the luminance weight.

7. The method as set forth in claim 1, 2, 3 or 4, wherein the method is applied to a method of displaying images in a plasma display unit.

8. An apparatus for displaying images, which divides at least one sub-field (SF1, SF2) among a plurality of sub-fields (SF1 to SF5) constituting a field of an image signal, into a plurality of sub-fields (SF1-1, SF1-2; SF2-1, SF2-2) each having a predetermined luminance weight, and pseudo-doubles a field frequency of the image signal,

   characterized in that a divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2) is preferentially selected to a non-divided sub-field (SF3 to SF5) for a gray scale at which images can be displayed with the divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2).

9. The apparatus as set forth in claim 8, wherein the divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2) is selected preferentially to a non-divided sub-field (SF3 to SF5) for the gray scale when the field frequency is smaller than 60 Hz.

10. The apparatus as set forth in claim 8, wherein an order of displaying the sub-fields when the field frequency is equal to or greater than 60 Hz is different from an order of displaying the sub-fields when the field frequency is smaller than 60 Hz.

11. The apparatus as set forth in claim 10, wherein the non-divided sub-field (SF3 to SF5) is selected preferentially to the divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2) when the field frequency is equal to or greater than 60 Hz, and the divided sub-field (SF1-1, SF1-2; SF2-1, SF2-2) is selected preferentially to the non-divided sub-field (SF3 to SF5) for the gray scale when the field frequency is smaller than 60 Hz.

12. The apparatus as set forth in claim 8, 9, 10 or 11, wherein the divided sub-fields (SF1-1, SF1-2; SF2-1, SF2-2) are arranged in an order of a magnitude of the luminance weight.

13. The apparatus as set forth in claim 8, 9, 10 or 11, wherein the non-divided sub-fields (SF3 to SF5) are arranged in an order of a magnitude of the luminance weight.

14. The apparatus as set forth in claim 8, 9, 10 or 11, wherein the apparatus is comprised of a plasma display unit.

FIG.1
PRIOR ART

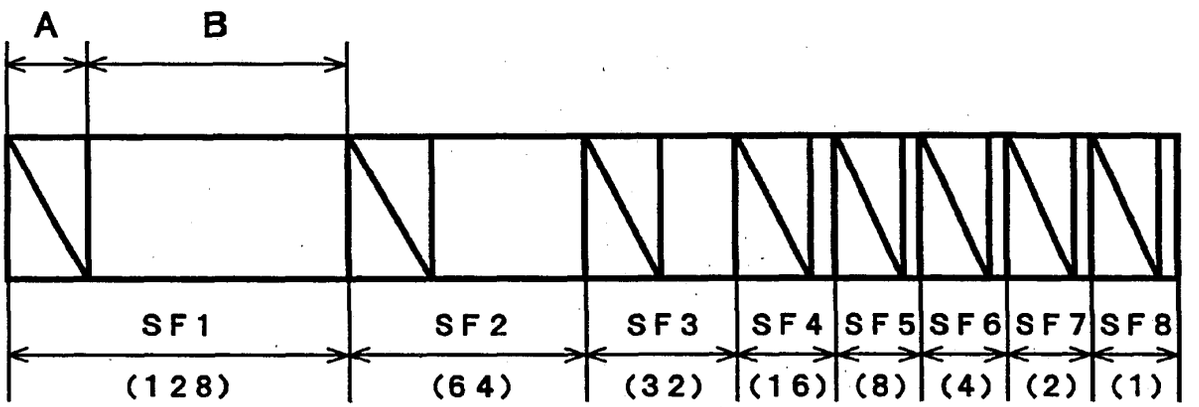

FIG.2
PRIOR ART

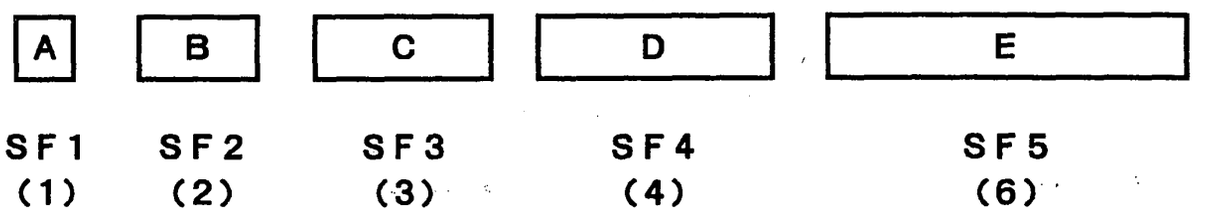

FIG.3
PRIOR ART

GRAY SCALES	A (1)	B (2)	C (3)	D (4)	E (6)
0					
1	O				
2		O			
3	O	O			
4	O		O		
5		O	O		
6	O	O	O		
7	O	O		O	
8	O		O	O	
9		O	O	O	
10	O	O	O	O	
11		O	O		O

FIG.4

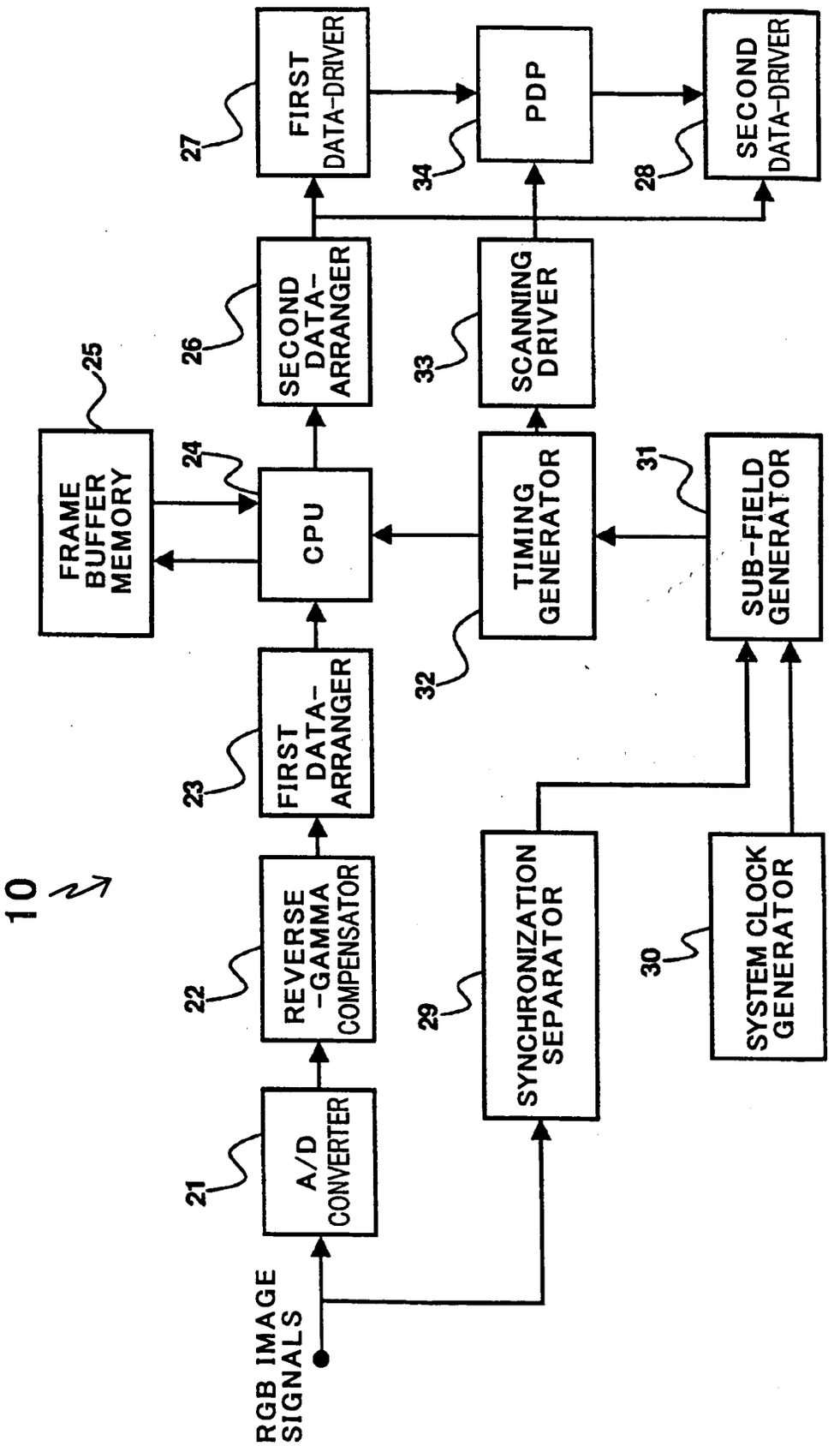
10
RGB IMAGE SIGNALS
A/D CONVERTER
21
REVERSE -GAMMA COMPENSATOR
22
FIRST DATA-ARRANGER
23
FRAME BUFFER MEMORY
25
CPU
24
SECOND DATA-ARRANGER
26
FIRST DATA-DRIVER
27
SYNCHRONIZATION SEPARATOR
29
TIMING GENERATOR
32
SCANNING DRIVER
33
PDP
34
SECOND DATA-DRIVER
28
SYSTEM CLOCK GENERATOR
30
SUB-FIELD GENERATOR
31

FIG.5

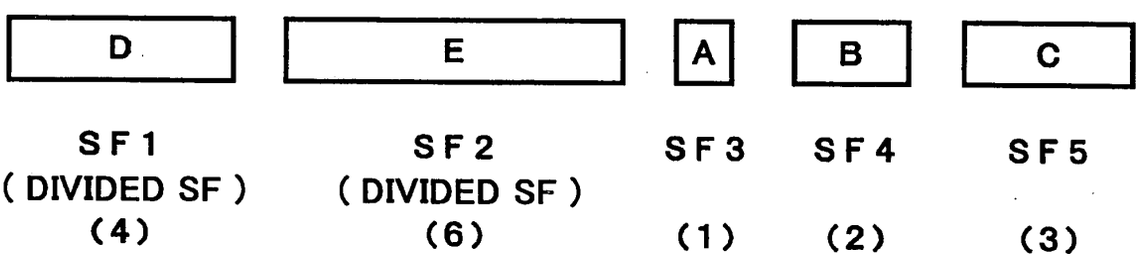

FIG.6

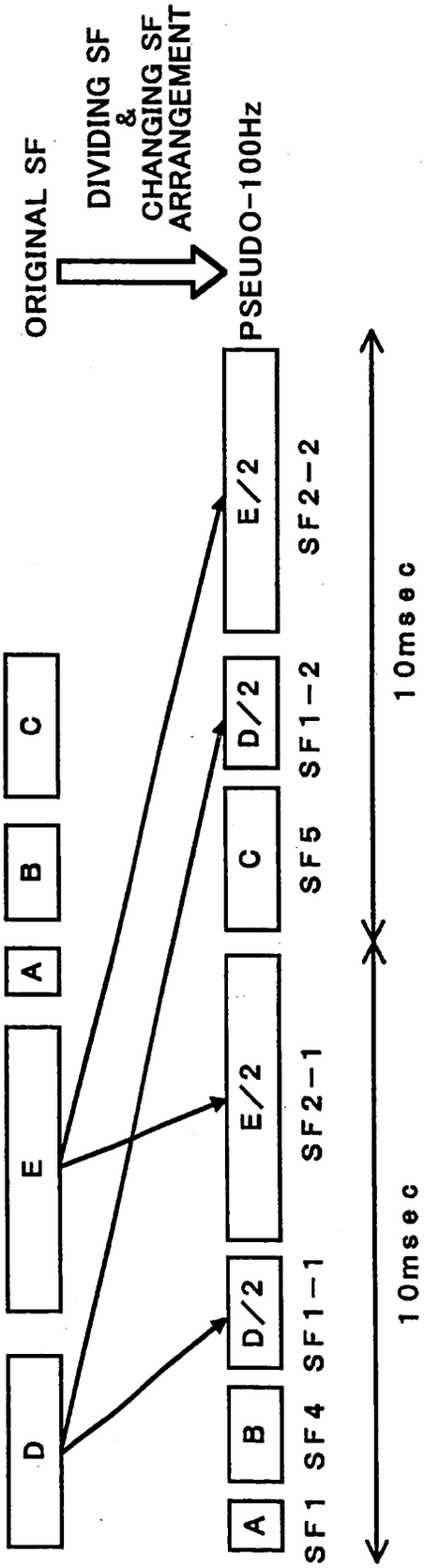
ORIGINAL SF
DIVIDING SF & CHANGING SF ARRANGEMENT
PSEUDO-100Hz
A
B
C
D
E
D/2
E/2
SF1
SF4
SF1-1
SF2-1
SF5
SF1-2
SF2-2
10msec
10msec

FIG.7

GRAY SCALES	D (4)	E (6)	A (1)	B (2)	C (3)
0					
1			O		
2				O	
3			O	O	
4	O				
5	O		O		
6	O			O	
7	O		O	O	
8	O		O		O
9	O		O	O	O
10	O	O			
11	O	O	O		

FIG.8

GRAY SCALES	A (1)	B (2)	D/2 (2)	E/2 (3)	C (3)	D/2 (2)	E/2 (2)	
0								
1	O△							
2		O△						
3	O△	O△						
4	O		△		O	△		◎
5	△	O	△		O	△		◎
6	O	O△	△		O	△		◎
7	O△	O△	O△			O△		
8	O△		O△		O△	O△		
9		O△	O△		O△	O△		
10	O	O	O△	△	O	O△	△	◎
11	△	O	△	O△	O	△	O△	◎
12		O△	O△	△		O△	O△	◎
13	O△	O△	O△	O△		O△	O△	
14	O△		O△	O△	O△	O△	O△	
15		O△	O△	O△	O△	O△	O△	
16	O△	O△	O△	O△	O△	O△	O△	

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 02 1482

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Place of search	Date of completion of the search	Examiner
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