(12) JAPANESE EXAMINED PATENT APPLICATION (B2)
(19) Japan Patent Office (JP)
(11) Patent No.
JP 4496852
(P4496852)
(45) Date of Issue: July 7, 2010 (Heisei 22)
(24) Registration Date: April 23, 2010 (Heisei 22)

(51) Int. Cl	FI		
G09F 9/30 (2006.01)	G09F	9/30	390C
G02B 5/20 (2006.01)	G02B	5/20	101
G02F 1/1343 (2006.01)	G02F	1/1343	

No. of Claims: 5 (15 Pages Total)

(21) Filing No. JP 2004-172538
(P2004-172538)
(22) Filing Date June 10, 2004
(Heisei 16)
(65) Publication No. JP 2005-352140
(P2005-352140A)
(43) Publication Date December 22, 2005
(Heisei 17)
Examination Request Date
February 27. 2007
(Heisei 19)

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(54) [Title of Invention] COLOR IMAGE DISPLAY DEVICE AND ELECTRONIC APPARATUS

(57) [Scope of Patent Claims]

[Claim 1]

A color image display device having a unit pixel consisting of four rectangular dots, comprising:
a first dot for displaying a first color as a component of the unit pixel,
a second dot for displaying a second color as a component of the unit pixel,
a third dot for displaying a third color as a component of the unit pixel, and
a fourth dot for displaying a fourth color as a component of the unit pixel, wherein:
the four dots that make up the unit pixel are disposed in a rectangular shape made up of four rectangles,
the second dot and the fourth dot display a mutually correlating color and are disposed on a diagonal on the rectangle shape made up of four rectangles formed by the unit pixel,
the second dot has a shape having cut-off portions wherein a corner disposed near the fourth dot and a corner of a diagonal thereof are cut off, and
the fourth dot has a shape having cut-off portions wherein two corners adjacent to a corner disposed near the second dot are cut off.

[Claim 2]

The color image display device according to claim 1, wherein: the first color is red,
the second color is green,
the third color is blue, and

the fourth color is green.
[Claim 3]
The color image display device according to claim 1, wherein: the first color is red,
the second color is either green or cyan,
the third color is blue, and
the fourth color is the other of either green or cyan.
[Claim 4]
The color image display device according to any one of claims 1 to 3, wherein on the second dot, the cut-off portion disposed near a center of the rectangle made up of four rectangles has a smaller shape than the cut-off portion disposed near an outer edge of the rectangle made up of four rectangles.
[Claim 5]
An electronic apparatus comprising the color image display device according to any one of claims 1 to 4.
[Detailed Description of Invention]
[Technical Field]
[0001]
The present invention relates to a color image display device and electronic device.
[Background Art]
[0002]
Some color image display devices that express color images create various colors by mixing the three primary colors: red (R: red), green (G: green), and blue (B: blue). Furthermore, conventionally, some devices display a color image using four colors, a neutral color (white) in addition to RGB (for example, see Patent Document 1). Moreover, conventionally, there are color liquid crystal display devices wherein the planar shape of the dots that are components of the pixels (unit pixels) is a shape wherein two corner portions on one diagonal line of a rectangle are cut off (for example, see Patent Document 2).
[Patent Document 1] JP 2002-6303 A
[Patent Document 2] JP H10-78590 A
[Disclosure of Invention]
[Problem to Be Solved by Invention]
[0003]
However, in the display device disclosed in Patent Document 1 above, a unit pixel is configured by four dots having respectively different display colors, but the placement of the dots of each color on unit pixels that are adjacent in the vertical direction of the screen is switched in the horizontal direction of the screen. When the display device disclosed in Patent Document 1, for example, attempts to display a straight line in the vertical direction of the screen in one of the three primary colors RGB, the outline thereof is rough. Therefore, the display device disclosed in Patent Document 1 has the problem of impeding the appearance of the display image.
[0004]
Furthermore, in the display device disclosed in Patent Document 2 above, dots (pixels) of the same color are disposed on a diagonal line heading from the top right to the bottom left of the screen, and the cut-off portions of each dot are disposed on the diagonal line. In the display device disclosed in Patent Document 2, when viewing the placement of dots of the same color, the directivity is not isotropic, and stripes (streaks) may be visible in a diagonal direction according to the placement of the dots when displaying an image. That is, all colored dots have directivity heading from the top right to the bottom left of the screen, and the direction thereof may not be overcome even when there are cut-off portions. Therefore, the display device disclosed in Patent Document 2 also has the problem of impeding the appearance of the display image.
[0005]
In light of the above, an object of the present invention is to provide a color image display device and electronic apparatus that can display color images having a high-quality appearance.
Moreover, an object of the present invention is to provide a color image display device and electronic apparatus having a wide range of color reproducibility that can prevent dots (pixels) of the same color from being placed next to each other in the vertical direction, the horizontal direction, and the diagonal direction of the screen, and that can display a high-quality color image.
[Means for Solving Problem]

[0006]
To achieve the above objects, the color image display device of the present invention has a unit pixel consisting of four rectangular dots, provided with: a first dot for displaying a first color as a component of the unit pixel, a second dot for displaying a second color as a component of the unit pixel, a third dot for displaying a third color as a component of the unit pixel, and a fourth dot for displaying a fourth color as a component of the unit pixel, wherein: the four dots that make up the unit pixel are disposed in a rectangular shape made up of four rectangles, the second dot and the fourth dot display a mutually correlating color and are disposed on a diagonal on the rectangle shape made up of four rectangles formed by the unit pixel, the second dot has a shape having cut-off portions wherein a corner disposed near the fourth dot and a corner of a diagonal thereof are cut off, and the fourth dot has a shape having cut-off portions wherein two corners adjacent to a corner disposed near the second dot are cut off.
To achieve the above objects, the color image display device of the present invention has a unit pixel consisting of a plurality of dots, is provided with: a first dot for displaying a first color as a component of the unit pixel, a second dot for displaying a second color as a component of the unit pixel, and a third dot for displaying a third color as a component of the unit pixel, wherein one dot from among the first to third dots is made up of two dots consisting of a first auxiliary dot and a second auxiliary dot, and the first auxiliary dot and the second auxiliary dot are disposed on a diagonal in the shape made by the unit pixel.
According to the present invention, two colors from among the three primary colors can be respectively expressed by one dot, and the other color of the three primary colors can be expressed by two dots to create a unit pixel. Thus, in the present invention, the range of the mixture ratio of the color expressed by two dots and the other color (for example, the ratio of the amount of green light and blue light and/or the ratio of the amount of green light and red light) can be widened, and a wider color expression becomes possible. Therefore, the color image display device of the present invention can have a wider color space than when expressing the three primary colors using three dots, and color reproducibility can be improved. Additionally, according to the present invention, two dots of the same color are disposed on a diagonal in the shape made by the unit pixel (for example, a rectangular shape), so dots of the same color are prevented from being adjacent in the vertical direction and the horizontal direction of the screen. Thus, the color image display device of the present invention can display a color image having a high-quality appearance.
[0007]
Furthermore, it is preferable in the color image display device of the present invention for the first color to be red, the second color to be green, the third color to be blue, the second dot to be made up of the first auxiliary dot and the second auxiliary dot, and the first auxiliary dot and the second auxiliary dot to both display green.
In the unit pixel in the present invention, from among the three primary colors, red and blue are respectively expressed using one dot and green is expressed using two dots. Thus, in the present invention, for example, the variable range of the ratio of the amount of green light and the amount of blue light, and the ratio of the amount of green light and the amount of red light can be expanded for each unit pixel, and a wider color expression is possible. Therefore, the color image display device of the present invention can have a wider color space than when expressing the three primary colors using three dots, color reproduction can be improved, and an image having a high-quality appearance can be displayed.
[0008]
To achieve the above objects, the color image display device of the present invention has a unit pixel consisting of a plurality of dots, is provided with: a first dot for displaying a first color as a component of the unit pixel, a second dot for displaying a second color as a component of the unit pixel, a third dot for displaying a third color as a component of the unit pixel, and a fourth dot for displaying a fourth color as a component of the unit pixel wherein the second dot creates a first auxiliary dot, the fourth dot creates a second auxiliary dot for displaying another color correlating to the display color of the first auxiliary dot, and the second dot and the fourth dot are disposed on a diagonal on the shape made by the unit pixel.
The fourth color can be a cyan-based color.
The fourth dot (second auxiliary dot G2) in the present invention has a correlating but different color from the display color of the second dot (first auxiliary dot G1). Generally, this means when the wavelength properties of light are expressed as a spectral sensitivity curve, the peak wavelength of the display color of the fourth dot is near the peak wavelength of the display color of the second dot. That is, it is preferable for the peak wavelength

of the fourth dot to be closer to the peak wavelength of the second dot rather than the peak wavelength of the first dot or the third dot. The cyan-based color can be, for example, light having a peak wavelength of 490 nm to 520 nm,

According to the present invention, because the unit pixel is configured by dots of four colors, the color space can be made wider than when configuring the unit pixel using dots of three colors (for example, RGB). Thus, the color image display device of the present invention can improve color reproduction. Additionally, according to the present invention, two dots of different yet correlating colors are disposed on a diagonal in the shape made by the unit pixel (for example, a rectangular shape), so dots having colors that can be recognized as being the same are prevented from being adjacent in the vertical direction and the horizontal direction of the screen. Furthermore, in the color image display device of the present invention, dots of the same color are not adjacent even in the diagonal direction of the screen. Therefore, the color image display device of the present invention can avoid occurrences of a streak pattern in the vertical direction and the horizontal direction of the screen, and an image having a high-quality appearance can be displayed.

[0009]

Furthermore, it is preferable in the color image display device of the present invention for the first color to be red, the second color to be green, the third color to be blue, and the fourth color to be cyan.

According to the present invention, various colors can be expressed using red, green, blue, and cyan as the four primary colors, and a wider color space can be expressed than that of a display device using three primary colors. Therefore, the color image display device of the present invention can display an image having high color reproduction.

[0010]

Furthermore, in the color image display device of the present invention, the unit pixel is configured by four dots, and the four dots that make up the unit pixel are disposed to surround one point and make up a rectangle made up of four rectangles. It is preferable for the four respective dots that make up the unit pixel to be rectangular and to be the same or substantially the same shape.

According to the present invention, the unit pixel is configured using four dots disposed in a rectangle made up of four rectangles, so each unit pixel can easily and accurately be regularly disposed, and the aperture ratio can be easily improved. Additionally, according to the present invention, two dots of the same color are disposed on a diagonal in the rectangular shape made by the unit pixel, so dots of the same color are prevented from being adjacent in the vertical direction and the horizontal direction of the screen. Thus, the color image display device of the present invention can display an image having a higher-quality appearance.

[0011]

Furthermore, it is preferable in the color image display device of the present invention for the first auxiliary dot and the second auxiliary dot to be shaped having cut-off portions wherein at least one corner of the rectangular shape is cut off, and to be disposed so that there is a cut-off portion near a space between the first auxiliary dot and the second auxiliary dot.

According to the present invention, there is a cut-off portion between the first auxiliary dot and the second auxiliary dot disposed to be adjacent on a diagonal line of the rectangle made up by the unit pixel. Thus, in the present invention, the cut-off portions can prevent dots having the same color (or a similar color) from being adjacent in the diagonal direction of the screen. Therefore, the color image display device of the present invention can avoid streaks in the diagonal direction, the vertical direction, and the horizontal direction of the screen, and an image having a higher-quality appearance can be displayed.

[0012]

Moreover, it is preferable in the color image display device of the present invention for the position of the cut-off portion of the first auxiliary dot and the position of the cut-off portion of the second auxiliary dot to be different.

According to the present invention, for example, the cut-off portion of the first auxiliary dot makes it possible to prevent dots of the same color (or another correlated color) from being close even in the diagonal direction from the top left to the bottom right of the screen, and the cut-off portion of the second auxiliary dot makes it possible to prevent dots of the same color (or another correlated color) from being close even in the diagonal direction from the top right to the bottom left of the screen. Therefore, in the present invention, the impeding of image quality due to dots of the same color (or another correlating color) being adjacent both in the diagonal

direction from the top left to the bottom right and the diagonal direction from the top right to the bottom left of the screen can be prevented by the cut-off portions. Therefore, the color image display device of the present invention can prevent streaks in the diagonal direction, the vertical direction, and the horizontal direction of the screen to a higher degree, and an image having a higher-quality appearance can be displayed.

[0013]

Moreover, it is preferable in the color image display device of the present invention for the cut-off portion of the first auxiliary dot and the cut-off portion of the second auxiliary dot to not be disposed near the center of the rectangle made up of four rectangles. Moreover, in the color image display device of the present invention, on the first auxiliary dot and the second auxiliary dot, the cut-off portion disposed near a center of the rectangle made up of four rectangles may have a smaller shape than the cut-off portion disposed near an outer edge of the rectangle made up of four rectangles.

According to the present invention, a cut-off portion is not disposed near the center of the unit pixel made up of four dots disposed in a rectangle made up of four rectangles, so the visual connectivity of the four dots thereof can be improved, and the visual connectivity of a certain unit pixel and an adjacent unit pixel can be reduced. Here, visual connectivity refers to the extent that a certain dot and an adjacent dot (or a certain unit pixel and an adjacent unit pixel) combine and appear as one or appear separately. Visual connectivity is lower as the extent that these appear to be separate is higher. The present invention can increase the visual connectivity of each unit pixel and reduce the visual connectivity between adjacent unit pixels and can thereby display a color image having a high-quality appearance.

[0014]

To achieve the above objects, the electronic apparatus of the present invention has the color image display device.

According to the present invention, an electronic apparatus can be provided that can display a color image having a high-quality appearance.

[Best Mode for Carrying Out the Invention]

[0015]

The color image display device according to embodiments of the present invention will be described below with reference to drawings.

(First Embodiment)

FIG. 1 is a plan view illustrating dot (pixel) shape and dot arrangement in a color image display device according to the first embodiment of the present invention. A color image display device 101 of the present embodiment has unit pixels 10 made up of four dots disposed as a grid in the vertical and horizontal direction. The unit pixels 10 are configured by four dots: one first dot 11, two second dots (12a and 12b), and one third dot 13, as a combined display unit. Here, the second dots (12a and 12b) are configured by a first auxiliary dot 12a disposed on a top right corner of a rectangle made by the unit pixel 10 and a second auxiliary dot 12b disposed on a bottom left corner of the rectangle thereof. In other words, the first auxiliary dot 12a and the second auxiliary dot 12b are disposed diagonally in the rectangle made by the unit pixel 10.

[0016]

For example, the first dot 11 is a pixel that displays red (R) as a first color. The second dots (12a and 12b) are pixels that display green (G) as a second color. That is, the first auxiliary dot 12a and the second auxiliary dot 12b are both pixels that display green. The third dot 13 is a pixel that displays blue (B) as a third color. It is preferable for the display colors of the first to third dots 11, 12a, 12b, and 13 to be the colors described above, but the present invention is not limited to these colors.

[0017]

Furthermore, the first to third dots 11, 12a, 12b, and 13 that configure the unit pixel 10 are respectively rectangular, and have substantially the same shape. It is preferable for the rectangular shape thereof to be a square, but it may also be an oblong rectangle. The four dots (first to third dots 11, 12a, 12b, and 13) that configure the unit pixel 10 are respectively disposed to surround one point, and make up a rectangle made up of four rectangles.

[0018]

Thus, according to the color image display device 101 of the present embodiment, from among the three primary colors RGB, R and B may be displayed by one dot and G may be displayed by two dots in the unit pixel 10. Here, the four dots (first to third dots 11, 12a, 12b, and 13) that configure the unit pixel 10 are respectively in

the same stage (luminance resolution) wherein the amount of light (or luminance) can be changed. Thus, the variable range of the brightness of G that can be displayed by two dots is twice the variable range of the brightness of R and B that are displayed by one dot. According to the color image display device 101 of the present embodiment, when compared to a device that displays the three primary colors RGB using three dots, the variable range of the mixture ratio of G and B and the mixture ratio of G and R can be expanded for each unit pixel 10, and a wider color expression is possible.

[0019]

Additionally, according to the color image display device 101 of the present embodiment, both the green first auxiliary dot 12a and second auxiliary dot 12b are disposed on a diagonal of the unit pixel 10. Therefore, the color image display device 101 can avoid occurrences wherein dots of the same color are adjacent to each other in the vertical direction and the horizontal direction of the screen. Thus, the color image display device 101 can display a color image having a high-quality appearance. Furthermore, in the color image display device 101, both the green first auxiliary dot 12a and second auxiliary dot 12b are disposed to be adjacent to each other in the diagonal direction of the screen. However, by controlling the brightness of only the first auxiliary dot 12a and the second auxiliary dot 12b, a streak pattern occurring in the diagonal direction of the screen can be easily avoided. Thus, the color image display device 101 of the present embodiment can display a color image having a further high-quality image while having a simple configuration.

[0020]

(Second Embodiment)

FIG. 2 is a plane view illustrating dot shape and dot arrangement in a color image display device according the second embodiment of the present invention. Similar to the color image display device 101 in the first embodiment, a color image display device 102 of the present embodiment has unit pixels 20 made up of four dots disposed as a grid in the vertical and horizontal direction. However, the unit pixels 20 are different than the unit pixels 10 in the first embodiment in that the four dots that configure it display respectively different colors.

[0021]

Specifically, the unit pixels 20 are configured by four dots: one first dot (R) 21, one second dot (G1) 22, one third dot (B) 23, and one fourth dot (G2) 24, as a combined display unit.

[0022]

For example, the first dot 21 is a pixel that displays red (R) as a first color. The second dot 22 is a pixel that displays green (G) as a second color. The third dot 23 is a pixel that displays blue (B) as a third color. The fourth dot 24 is a pixel that displays cyan (C) as a fourth color. It is preferable for the display colors of the first to fourth dots 21, 22, 23, and 24 to be the colors described above, but the present invention is not limited to these colors.

[0023]

More specifically, for example, when a light wavelength characteristic is expressed as a spectral sensitivity curve, the peak wavelength of the first dot (red) 21 may be 640 nm, the peak wavelength of the second dot (green) 22 may be 550 nm, the peak wavelength of the third dot (blue) 23 may be 470 nm, and the peak wavelength of the fourth dot (cyan) may be 500 nm. Thus, the distance between the peak wavelengths of the second dot 22 and the fourth dot 24 is 50 nm. Meanwhile, the distance between peak wavelengths of the second dot and the first dot is 90 nm, and the distance between peak wavelengths of the second dot and the third dot is 80 nm. In this manner, the second dot 22 (first auxiliary dot G1) and the fourth dot 24 (second auxiliary dot G2) have a close peak wavelength and display a different correlated color. Furthermore, the second dot 22 and the fourth dot 24 are disposed on a diagonal on the rectangle formed by the unit pixel 20, and correspond to the first auxiliary dot G1 and the second auxiliary dot G2 of the present invention.

[0024]

Furthermore, the first to fourth dots 21, 22, 23, and 24 that configure the unit pixel 20 are respectively rectangular, and have substantially the same shape. It is preferable for the rectangular shape thereof to be, for example, a square, but it may also be an oblong rectangle. The four dots (first to fourth dots 21, 22, 23, and 24) that configure the unit pixel 20 are respectively disposed to surround one point, and make up a rectangle made up of four rectangles.

[0025]

Thus, according to the color image display device 102 of the present embodiment, because the unit pixel 20 is configured by dots of the four colors RGBC, the color space can be made wider than when configuring the unit

pixel using dots of three colors. Thus, according to the present embodiment, the range of color reproduction can be made wider, and an even higher-quality color image display device can be provided than that of the first embodiment.

[0026]

Additionally, according to the color image display device 102 of the present embodiment, the second dot 22 and the fourth dot 24 disposed on a diagonal in the unit pixel 20 display different colors that are correlated, so dots having colors that are recognized as being the same are not adjacent in the vertical direction and the horizontal direction of the screen. Therefore, the color image display device 102 can avoid occurrences of a streak pattern in the vertical direction and the horizontal direction of the screen to a higher degree. Additionally, in the color image display device 102, dots of the same color are not adjacent even in the diagonal direction, so occurrences of streak patterns can be reduced even in the diagonal direction of the screen, and an image having a wide range of color reproduction and a high-quality appearance can be displayed.

[0027]

(Third Embodiment)

FIG. 3 is a plane view illustrating dot shape and dot arrangement in a color image display device according the third embodiment of the present invention. The difference between the present embodiment and the first embodiment is that a first auxiliary dot 32a and a second auxiliary dot 32b of four dots that configure a unit pixel 30 of the present embodiment are respectively shaped having cut-off portions K1a, K1b, K2a, and K2b. In relation to other configurations, the color image display device 103 of the present embodiment illustrated in FIG. 3 is the same as the color image display device 101 of the first embodiment illustrated in FIG. 1. In other words, in the color image display device 103 of the present embodiment, the cut-off portions K1a, K1b, K2a, and K2b are provided on the shape of the first auxiliary dot 12a and the second auxiliary dot 12b in the color image display device 101 of the first embodiment.

[0028]

Next, the present embodiment will be described in further detail. The color image display device 103 of the present embodiment has unit pixels 30 made up of four dots disposed as a grid in the vertical and horizontal direction. The unit pixels 30 are configured by four dots: one first dot 31, two second dots (32a and 32b), and one third dot 33, as a combined display unit. Here, the second dots (32a and 32b) are configured by a first auxiliary dot 32a disposed on a top right corner of a rectangle made by the unit pixel 30 and a second auxiliary dot 32b disposed on a bottom left corner of the rectangle thereof. In other words, the first auxiliary dot 32a and the second auxiliary dot 32b are disposed diagonally in the rectangle made by the unit pixel 30.

[0029]

For example, the first dot 31 is a pixel that displays red (R) as a first color. The second dots (32a and 32b) are pixels that display green (G) as a second color. That is, the first auxiliary dot 32a and the second auxiliary dot 32b are both pixels that display green. The third dot 33 is a pixel that displays blue (B) as a third color. It is preferable for the display colors of the first to third dots 31, 32a, 32b, and 33 to be the colors described above, but the present invention is not limited to these colors.

[0030]

Next the shape of each dot, which is a characteristic of the present embodiment, will be described. The first dot 31 and the third dot 33 are respectively rectangular and have substantially the same shape. It is preferable for the rectangular shape thereof to be a square, but it may also be an oblong rectangle.

[0031]

The rectangular shape of the first auxiliary dot 32a has the upper left corner and the lower right corner (diagonal corner) cut off. That is, the first auxiliary dot 32a has a cut-off portion K1a on the upper left part of the rectangular shape, and has a cut-off portion K1b on the lower right part thereof, which is the diagonal thereof. The rectangular shape of the second auxiliary dot 32b has the upper right corner and the lower left corner (diagonal corner) cut off. That is, the second auxiliary dot 32b has a cut-off portion K2a on the upper right part of the rectangular shape, and has a cut-off portion K2b on the lower left part thereof, which is the diagonal thereof.

[0032]

In this manner, the cut-off portions K1a and K1b of the first auxiliary dot 32a and the cut-off portions K2a and K2b of the second auxiliary dot 32b are disposed in symmetrical positions (opposite positions) with a horizon line passing through the center of the dot shape as a reference. The objects are disposed so that there is the cut-

off portion K2b (or cut-off portions K1a, K1b, or K2a) between the first auxiliary dot 32a and the second auxiliary dot 32b of the same color. Moreover, the four dots (first to third dots 31, 32a, 32b, and 33) that configure the unit pixel 30 are respectively disposed to surround one point, and make up a rectangle made up of four rectangles.

[0033]

Thus, according to the color image display device 103 of the present embodiment, one cut-off portion K1a, K1b, and K2a is disposed between the first auxiliary dot 32a and the second auxiliary dot 32b disposed to be adjacent on a diagonal line of the rectangle made up by the unit pixel 30. According to the color image display device 103 of the present embodiment, the cut-off portions K1a and K1b make it possible to prevent dots of the same color (the first auxiliary dot 32a and the second auxiliary dot 32b) from being adjacent from the top left to the bottom right of the screen, and the cut-off portions K2a and K2b make it possible to prevent dots of the same color from being adjacent from the top right to the bottom left of the screen. Therefore, the color image display device 103 of the present embodiment can prevent streaks in the diagonal direction, vertical direction, and horizontal direction, and an image having a higher-quality appearance can be displayed.

[0034]

FIG. 4 is a plane view illustrating another example of the third embodiment of the present invention. In a color image display device 104 according to the present example, the shape of the first auxiliary dot 32a and the second auxiliary dot 32b illustrated in FIG. 3 is applied to the first auxiliary dot G1 (second dot 22) and the second auxiliary dot G2 (fourth dot 24) of the color image display device 104 of the second embodiment illustrated in FIG. 2.

[0035]

That is, a unit pixel 40 in the color image display device 104 corresponds to the unit pixel 30 in FIG. 3. The unit pixel 40 is configured by, for example, a first dot 41 for displaying red (R), a second dot 42 for displaying green (G, G1), a third dot 43 for displaying blue (B), and a fourth dot 44 for displaying cyan (C, G2). Here, the shape of the first dot 41 is the same as that of the first dot 31 in FIG. 3. The shape of the second dot 42 is the same as that of the first auxiliary dot 32a in FIG. 3 and has cut-off portions K1a and K1b. The shape of the third dot 43 is the same as that of the third dot 33 in FIG. 3. The shape of the fourth dot 44 is the same as that of the second auxiliary dot 32b in FIG. 3 and has cut-off portions K2a and K2b.

[0036]

Thus, according to the color image display device 104 of the present embodiment, one cut-off portion K1a, K1b, K1b, and K2a is disposed between the second dot 42 and the fourth dot 44 disposed to be adjacent on a diagonal line of the rectangle made up by the unit pixel 40 and that display different yet correlating colors. Thus, according to the color image display device 104 of the present embodiment, the cut-off portions K1a and K1b make it possible to prevent dots of two colors having relatively similar peak wavelengths on a spectral sensitivity curve (the first auxiliary dot G1 and the second auxiliary dot G2) from being adjacent from the top left to the bottom right of the screen, and the cut-off portions K2a and K2b make it possible to prevent the dots of two colors having relatively similar peak wavelengths from being adjacent from the top right to the bottom left of the screen. Therefore, the color image display device 104 of the present embodiment can widen the range of color reproduction, can quickly prevent streaks in the diagonal direction, vertical direction, and horizontal direction, and an image having a higher-quality appearance can be displayed.

[0037]

FIG. 5 is a plane view illustrating another shape of cut-off portions in the present embodiment. The dot 51 illustrated in FIG. 5(a) and the dot 52 illustrated in FIG. 5(b) correspond to the second auxiliary dot 32b in FIG. 3 and the fourth dot 44 in FIG. 4. That is, the dots 51 and 52 are a modified example of the shape of the cut-off portions of the second auxiliary dot 32b and the fourth dot 44.

[0038]

The dot 51 is a first modified example of a cut-off portion. The dot 51 is shaped having cut-off portions K3a and K3b on a corner of a diagonal of a rectangular shape. The outline of the cut-off portions K3a and K3b is configured by a curved line. This curved line has a protruding shape from the center of the dot 51 to the exterior.

[0039]

The dot 52 is a second modified example of a cut-off portion. The dot 52 is shaped having cut-off portions K4a and K4b on a corner of a diagonal of a rectangular shape. The outline of the cut-off portions K4a and K4b are

configured by a straight line, but the cut-off portion K4a has a shape being more cut off than the cut-off portion K4b. Here, the cut-off portion K4b may have a shape being more cut off than the cut-off portion K4a.

[0040]

Note that the modified examples of the cut-off portions illustrated in FIG. 5, can be applied to the first auxiliary dot 32a in FIG. 3 and the second dot 42 in FIG. 4 by changing the position of the cut-off portion on the dots 51 and 52. Furthermore, an invention wherein the shape of a pixel such as a color filter is formed in not a rectangular shape, but a shape having the corners cut off has been proposed conventionally, and conventional art prevents variations or the like in shape using processes such as etching. The conventional cut-off shape does not bring about the same action and effects as the cut-off portions in the present embodiment wherein the corners of dots of a specific color are cut off.

[0041]

Furthermore, in FIG. 3 and FIG. 4, a gap is formed between each dot, and, for example, a scanning line may be disposed in each gap continuing in the horizontal direction of the screen. From among driving elements provided on each dot (for example, a TFT: thin film transistor), this scanning line may be connected to a TFT gate electrode on the same row. Furthermore, in FIG. 3 and FIG. 4, a gap is formed between each dot, and, for example, a signal wire may be disposed in each gap continuing in the vertical direction of the screen. From among TFT provided on each dot, this signal wire may have a TFT source (or drain) connected on the same column.

[0042]

Furthermore, in FIG. 3 and FIG. 4, a TFT for driving each dot, an electrode of a holding capacitor, or the like may be disposed on parts that oppose the outline of the cut-off portions K1a, K1b, K2a, and K2b (region of the cut-off corners). Thus, all regions of the screen, including regions of the cut-off corners, can be effectively utilized, for example, the shape of the pixel electrode and the shape of the pixel of the color filter can be made to be similar, and the overall aperture ratio can be improved.

[0043]

Note that in such cases, electrodes configuring the TFT or the electrode configuring the holding capacitor provided on the region of the cut-off corners are not limited to TFT or holding capacitor electrodes for the pixel electrode of dots corresponding to the cut-off portions, and may be TFT or holding capacitors electrodes for the pixel electrode of dots adjacent to these dots. For example, in FIG. 4, the TFT and holding capacitor electrode formed on the region of the cut-off portion K1a of the second dot 42 may be a TFT and holding capacitor electrode for driving the first dot 41, and the TFT and holding capacitor electrode formed on the region of the cut-off portion K1b of the second dot 42 may be a TFT and holding capacitor electrode for driving the second dot 42.

[0044]

(Fourth Embodiment)

FIG. 6 is a plane view illustrating dot shape and dot arrangement in a color image display device according to the fourth embodiment of the present invention. FIG. 6(a) illustrates a unit pixel 60 of a color image display device of a first example in the present embodiment. The difference between the unit pixel 60 of the present embodiment and the unit pixels 30 and 40 in FIG. 3 and FIG. 4 is that there is no cut-off portion disposed near the center on the rectangle made up of four rectangles formed by four dots 61, 62, 63, and 64 that configure the unit pixel 60.

[0045]

Specifically, in the unit pixel 60, the dot 61 corresponds to the first dot 31 in FIG. 3 and the first dot 41 in FIG. 4, and has the same shape as the first dot 31 and the first dot 41. The dot 62 corresponds to the first auxiliary dot 32a in FIG. 3 and the second dot 42 in FIG. 4, and has the same shape as the first auxiliary dot 32a and the second dot 42. Therefore, the dot 62 has two cut-off portions K5a and K5b disposed on a diagonal. The dot 63 corresponds to the third dot 33 in FIG. 3 and the third dot 43 in FIG. 4, and has the same shape as the third dot 33 and the third dot 43.

[0046]

The dot 64 corresponds to the second auxiliary dot 32b in FIG. 3 and the fourth dot 44 in FIG. 4, but has a different shape from the second auxiliary dot 32b and the fourth dot 44. That is, the second auxiliary dot 32b and the fourth dot 44 have the two cut-off portions K2a and K2b, but the dot 64 of the present embodiment has only one cut-off portion K6. In other words, the unit pixel 60 of the present embodiment is configured to not be

provided with the cut-off portion K2b in the unit pixels 30 and 40 of the third embodiment. Furthermore, the second dot 62 and the fourth dot 64 may have the same display color (for example, green) and may have a different yet correlating color (for example, green and cyan).

[0047]

Thus, according to the present embodiment, a cut-off portion is not disposed near the center of the unit pixel 60 made up of four dots 61, 62, 63, and 64 disposed in a rectangle made up of four rectangles, so the visual connectivity of the four dots thereof can be improved, and the visual connectivity of a certain unit pixel 60 and an adjacent unit pixel 60 can be reduced. In other words, when attempting to display as a group in the unit pixel 60, the visual connectivity of the four dots 61, 62, 63, and 64 can be improved, and the visual connectivity of a certain unit pixel 60 and an adjacent unit pixel 60 can be reduced. Therefore, the color image display device of the present embodiment can display a color image having a high-quality appearance.

[0048]

Furthermore, FIG. 6(a) is configured so that no cut-off portions are provided on the diagonal of the cut-off portion K6 on the dot 64, but it is also possible to configure so that a cut-off portion smaller than the cut-off portion K6 is provided on the diagonal of the cut-off portion K6 on the dot 64. Even in such a configuration, when attempting to display as a group in the unit pixel 60, the visual connectivity of the four dots 61, 62, 63, and 64 can be improved, and the visual connectivity of a certain unit pixel 60 and an adjacent unit pixel 60 can be reduced.

[0049]

FIG. 6(b) illustrates a unit pixel 70 of a color image display device of a second example in the present embodiment. The difference between the unit pixel 70 of the present embodiment and the unit pixels 30 and 40 in FIG. 3 and FIG. 4 is that there are respective cut-off portions on the four dots 71, 72, 73, and 74 that configure the unit pixel 70.

[0050]

More specifically, in the unit pixel 70, the dot 71 corresponds to the first dot 31 in FIG. 3 and the first dot 41 in FIG. 4, but has a different shape from the first dot 31 and the first dot 41. That is, first dot 31 and the first dot 41 do not have cut-off portions, but the dot 71 has two cut-off portions K9a and K9b. The dot 72 corresponds to the first auxiliary dot 32a in FIG. 3 and the second dot 42 in FIG. 4, and has the same shape as the first auxiliary dot 32a and the second dot 42. The dot 72 has two cut-off portions K7a and K7b. The dot 73 corresponds to the third dot 33 in FIG. 3 and the third dot 43 in FIG. 4, but has a different shape from the third dot 33 and the third dot 43. That is, the third dot 33 and the third dot 43 do not have cut-off portions, but the dot 73 has two cut-off portions K10a and K10b. The dot 74 corresponds to the second auxiliary dot 32b in FIG. 3 and the fourth dot 44 in FIG. 4, and has the same shape as the second auxiliary dot 32b and the fourth dot 44. The dot 74 has two cut-off portions K8a and K8b.

[0051]

Additionally, the two cut-off portions K9a and K9b on the dot 71 are disposed on a diagonal line on the diagonal line on the dot 71. However, the diagonal line on which the cut-off portions K9a and K9b are disposed is oriented to be 180 degrees off the diagonal line on which the cut-off portions K10a and K10b are disposed on the dot 73. Furthermore, the second dot 72 and the fourth dot 74 may have the same display color (for example, green) and may have a different yet correlating color (for example, green and cyan).

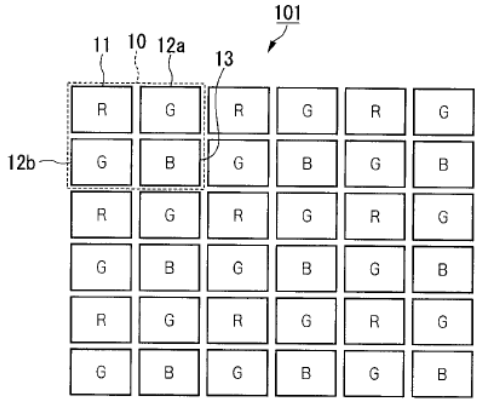
[0052]

As such, in the present embodiment, the four dots 71, 72, 73, and 74 disposed in a rectangle made up of four rectangles in the unit pixel 70 have two respective cut-off portions. However, when comparing the dot 71 and the dot 73, and the dot 72 and the dot 74 disposed on a diagonal in the unit pixel 70, the positions on which the cut-off portions are provided on each dot differ. That is, a cut-off portion is provided on the top right corner and the bottom left corner of the dot for the dots 71 and 74, but a cut-off portion is provided on the top left corner and the bottom right corner of the dot for the dots 72 and 73. In other words, as illustrated in FIG. 6(b), when viewing the dots 71 and 72 that are adjacent in the horizontal direction of the screen, there is a maximum of two adjacent corners that have (or don't have) a cut-off portion (K9b and K7a), when viewing the dots 71 and 74 (or dots 72 and 73) that are adjacent in the vertical direction of the screen, there are no adjacent corners having a cut-off portion, and when viewing the dots 71 and 73 (or dots 72 and 74) that are adjacent in the diagonal direction of the screen, there are no adjacent corners having a cut-off portion. Thus, according to the color image

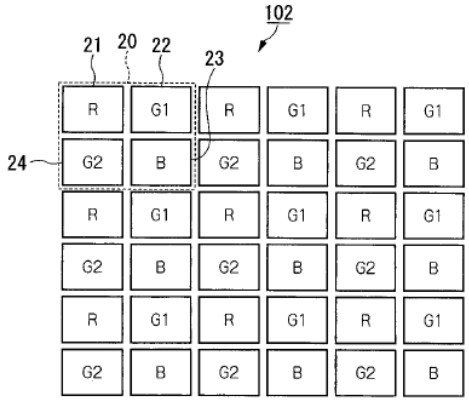
display device of the present embodiment, streaks can be prevented in the vertical, horizontal, and diagonal directions of the screen, and a color image having a high-quality appearance can be displayed.
[0053]
(Effect of Present Embodiment)
FIG. 7 is a plane view illustrating a striped dot shape and dot arrangement in a conventional color image display device. FIG. 8 is a plane view illustrating a delta dot shape and dot arrangement in a conventional color image display device. For stripes, dots having the same color are adjacent in the vertical direction (or horizontal direction). For delta, dots having the same color are adjacent in the diagonal direction. The striped or delta color image display devices have an inconvenience of a streak pattern appearing along the direction that dots having the same color are arranged.
[0054]
According to the color image display device according to the first to fourth embodiments above, dots having the same color are prevented from being adjacent, so the appearance of a streak pattern above can be prevented and a color image having a high-quality appearance can be displayed. Furthermore, according to the color image display device according to the third and fourth embodiments, the cut-off portions are provided irregularly, so that, for example, the shape of a black matrix forming a light shielding portion can be made irregular, and a streak pattern or the like appearing can be prevented to a higher degree.
[0055]
(Electric Apparatus)
Next, an electric apparatus will be described that has the color image display device of the above embodiments as a component thereof.
FIG. 9(a) is a perspective view illustrating an example of a mobile telephone. In FIG. 9(a), reference numeral 600 represents a mobile telephone main unit and reference numeral 601 represents a display unit made up of the color image display device according to the above embodiments. FIG. 9(b) is a perspective view illustrating an example of a mobile information processing device such as a word processor or a personal computer. In FIG. 9(b), reference numeral 700 represents an information processing device, reference numeral 701 represents an input unit such as a keyboard, reference numeral 702 represents a display unit made up of the color image display device according to the above embodiments, and reference numeral 703 represents an information processing device main unit. FIG. 9(c) is a perspective view illustrating an example of a wristwatch-type electronic apparatus. In FIG. 9(c), reference numeral 800 represents a clock main unit and reference numeral 801 represents a display unit made up of the color image display device according to the above embodiments.
[0056]
Because the electronic apparatus illustrated in FIG. 9 is provided with the color image display device of the above embodiments, the range of color reproducibility is wide, unnecessary connecting of colors can be prevented, and a color image having a high-quality appearance can be displayed.
[0057]
Note that the technical scope of the present invention is not limited to the above embodiments. Various modifications can be added as long as the main points of the present invention are not deviated from. For example, the specific materials or layered configuration given in the embodiments are mere examples, and can be modified as appropriate.
[0058]
The color image display device according to the present invention can be applied to liquid crystal display devices, organic EL display devices, plasma display devices, projectors, and the like.
[Brief Description of Drawings]
[0059]
[FIG. 1] is a plane view of the main portions of a color image display device according to the first embodiment of the present invention.
[FIG. 2] is a plane view of the main portions of a color image display device according to the second embodiment of the present invention.
[FIG. 3] is a plane view of the main portions of a color image display device according to the third embodiment of the present invention.

[FIG. 4] is a plane view of another example of the color image display device according to the third embodiment of the present invention.
[FIG. 5] is a plan view illustrating another example of cut-off portions in the same embodiment.
[FIG. 6] is a plane view of the main portions of a color image display device according to the fourth embodiment of the present invention.
[FIG. 7] is a plane view illustrating a striped color image display device.
[FIG. 8] is a plane view illustrating a delta color image display device.
[FIG. 9] is a perspective view illustrating an electronic apparatus according to an embodiment of the present invention.
[Description of Reference Numerals]
[0060]
10, 20, 30, 40, 60, 70... Unit pixel, 11, 21, 31, 41... First dot, 12a, 32a... First auxiliary dot, 12b, 32b... Second auxiliary dot, 13, 23, 33, 43... Third dot, 21, 42... Second dot, 24, 44... Fourth dot, 51, 52, 61, 62, 63, 64, 71, 72, 73, 74... Dot, 101, 102, 103, 104... Color image display device, K1a, K1b, K2a, K2b, K3a, K3b, K4a, K4b, K5a, K5b, K6, K7a, K7b, K8a, K8b, K9a, K9b, K10a, K10b... Cut-off portion

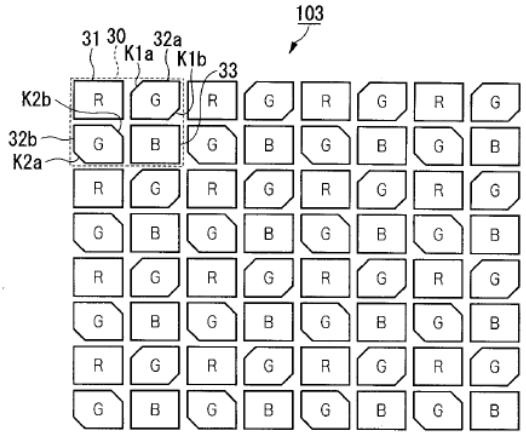
[FIG. 1]



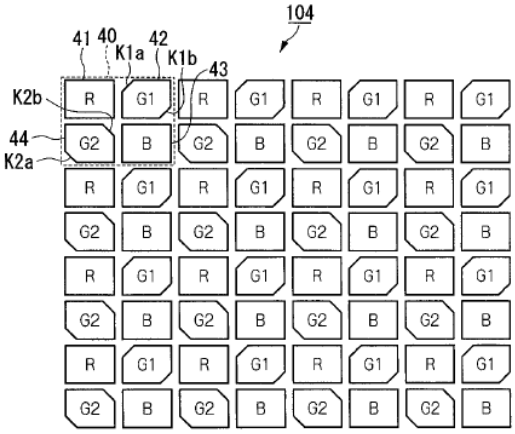
[FIG. 2]



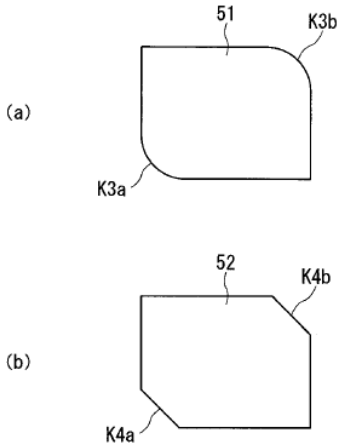
[FIG. 3]



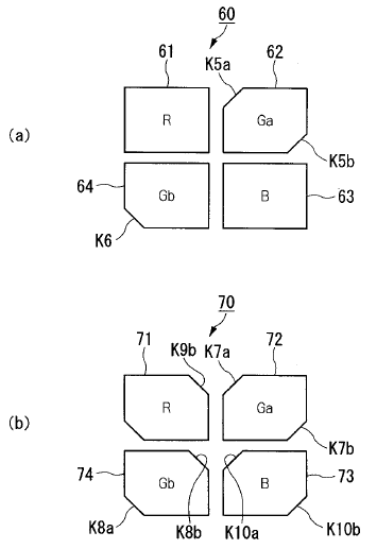
[FIG. 4]



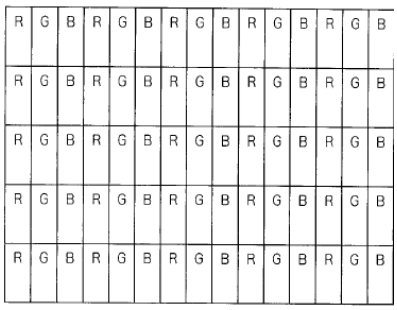
[FIG. 5]



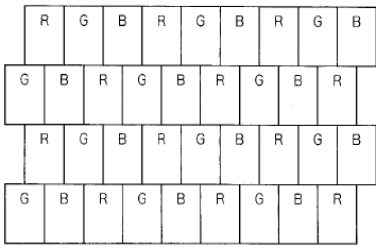
[FIG. 6]



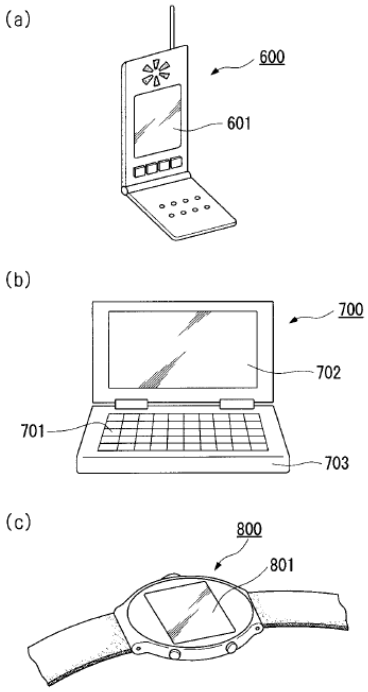
[FIG. 7]



[FIG. 8]



[FIG. 9]



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(58) Searched Technical Field (Int. Cl., DB Name)
G09F 9/30
G02B 5/20
G02F 1/1343

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) ss:
COUNTY of)

CERTIFICATE OF ACCURACY

I, Travis Huntsman, hereby declare:

That I possess advanced knowledge of the Japanese and English languages.

My qualifications are as follows:

- 9 years professional translation experience
- B.A. in Japanese

The attached *Japanese* into *English* translation has been translated by me and to the best of my knowledge and belief, it is a true and accurate translation of:

JP 4496852B2 (Murai)

I understand that willful false statement and link are punishable by fine or imprisonment, or both (18 U.S.C. 1001) and may jeopardize the validity of the application or any patent issuing thereon. I declare under the penalty of the perjury that all statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true.

Dated: 5/4/2023

Travis Huntsman
Linguist

Sworn to and signed before ME
This 2nd day of May, 2023

Notary Public

JEFFREY MAMERA
Notary Public, State of Texas
Comm. Expires 12-07-2026
Notary ID 134094816

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