



(11)

EP 3 382 685 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.10.2018 Bulletin 2018/40

(51) Int Cl.:
G09G 3/3208 ^(2016.01) **G09G 3/22** ^(2006.01)
G09G 3/20 ^(2006.01)

(21) Application number: **17305392.7**

(22) Date of filing: **31.03.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

- **POULI, TANIA**
35576 CESSON SEVIGNE CEDEX (FR)
- **MORVAN, PATRICK**
35576 CESSON SEVIGNE CEDEX (FR)
- **GUERMOUD, HASSANE**
35576 CESSON SEVIGNE CEDEX (FR)

(71) Applicant: **Thomson Licensing**
92130 Issy-les-Moulineaux (FR)

(74) Representative: **Vidon Brevets & Stratégie**
16B, rue de Jouanet
BP 90333
35703 Rennes Cedex 7 (FR)

(72) Inventors:
• **KERVEC, JONATHAN**
35576 CESSON SEVIGNE CEDEX (FR)

(54) **METHOD AND DEVICE FOR ADAPTING A RENDERING VISIBILITY**

(57) A method for adapting a rendering visibility of a content is disclosed. A salient idea is to modify color component values of an element of the content so as to relatively increase a color component for which a human sensitivity is high, with regards to another color component for which the human sensitivity is low, the modification being independent of the color component values of the element of the content, the modification not necessarily preserving the creative intent of the content A color component for which the human sensitivity is high typically corresponds to a green or a yellow color component of a displayed signal and a color component for which the human sensitivity is low typically corresponds to a blue or a red color component of a displayed signal.

Relatively increasing on one hand for example a green and/or a yellow color component value of an element with regards to a red and/or a blue color component value of the element in the other hand advantageously increases the visibility of the pixel without increasing the power consumption of the device. Moreover relatively decreasing a color component (red or blue) with regards to another color component (green or yellow) by applying a same ratio factor to all the values of that color component, the ratio factor being independent from the values of the color component, is advantageous as it does not require an analysis of the color component values prior determining and applying the ratio factor. The color component modification remains simple and efficient.

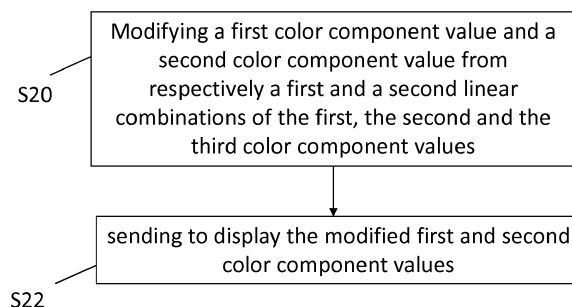


Figure 2

EP 3 382 685 A1

Description**1. TECHNICAL FIELD**

5 **[0001]** The technical field of the disclosed method and device is related to mobile application rendering under varying viewing conditions.

2. BACKGROUND ART

10 **[0002]** Visible rendering of content is challenging in bright conditions, as for example in a sunny weather outdoor environment. Some known methods propose to increase the luminance of display screens so as to improve the visibility of a rendered content under very bright conditions. They for example propose to apply a same multiplying factor to all the color components of a content in order to increase the luminance of the content while preserving the initial creative intent of the content. Increasing the luminance however has a drastic impact on the battery life time as it is also known that increasing the luminance of the displayed content increases the power consumption of the display device.

15 **[0003]** Some techniques, such as Automatic Brightness Limiters (ABL) are also known for preserving the battery life time and/or limiting the power supply size by controlling the power level of pixels, expressed for example as an Average Power Level (APL). As long as the APL remains under a given threshold, the brightness is not limited, and the power consumption increases with an increase of the overall luminance of the content. When the APL reaches the given threshold, the power consumption is limited by thresholding the highlights of the content. In bright conditions, the ABL limits the increase of the luminance of the content so as to preserve the battery life time or to avoid draining power from the battery or power supply above its capability. This consequently limits the content visibility under bright viewing conditions.

20 **[0004]** A new technique has been recently disclosed in US patent application US 2015/0187331 for controlling luminance of a display device. This new technique is capable of reducing power consumption caused by luminance improvement by controlling luminance of the image in a manner of improving luminance in an achromatic manner. More precisely, the approach is to decrease the luminance of parts of the image having a low gray level, and to boost the luminance of other parts of the image having a high gray level. The boosting parameters of a given pixel are dependent on the color value of the pixel. This technique preserves the colors of the image as it only adjusts achromatic parts. However the visibility improvements are highly dependent on the types of images: visibility improvements of images with very few achromatic colors are very limited via such technique. Moreover, the approach relies on an analysis of the image content in order to determine various coefficients implying an additional complexity.

25 **[0005]** Some new methods are needed to improve further a visibility of a content under bright viewing conditions, while keeping, or further limiting the power consumption of the device without the limitations of existing techniques.

3. SUMMARY

30 **[0006]** A salient idea is to adapt a rendering visibility of a content by modifying color component values of an element of the content so as to relatively increase a color component for which a human sensitivity is high, with regards to another color component for which the human sensitivity is low, the modification being independent of the color component values of the element of the content, the modification not necessarily preserving the creative intent of the content. A color component for which the human sensitivity is high typically corresponds to a green or a yellow color component of a displayed signal and a color component for which the human sensitivity is low typically corresponds to a blue or a red color component of a displayed signal.

35 **[0007]** Relatively increasing on one hand for example a green and/or a yellow color component value of an element with regards to a red and/or a blue color component value of the element in the other hand advantageously increases the visibility of the pixel without increasing the power consumption of the device. Moreover relatively decreasing a color component (red or blue) with regards to another color component (green or yellow) by applying a same ratio factor to all the values of that color component, the ratio factor being independent from the values of the color component, is advantageous as it does not require an analysis of the color component values prior determining and applying the ratio factor. The color component modification remains simple and efficient.

40 **[0008]** To that end a method adapting a rendering visibility of a content is disclosed. An element of the content is represented by at least a first, a second and a third color component values. The method comprises:

- 45 - obtaining a modified value of a first color component value and a modified value of a second color component value from respectively a first and a second linear combinations of the first, the second and the third color component values, the first and the second linear combinations relatively increasing a the first color component for which a human visual sensitivity is high with regards to a the second color component for which the human visual sensitivity

is low;

- adapting the rendering visibility by sending to display the modified first and second color component values;

[0009] The method is characterized in that parameters of the first and second linear combinations are independent of the first, second and third color component values.

[0010] According to a particularly advantageous variant, the method further comprises obtaining a modified value of a third color component value, from a third linear combination of the first, second and third color component values, parameters of the third linear combination being independent from the first, second and third color component values, the third linear combination decreasing a the third color component for which the human visual sensitivity is low, the modified third color component value being further sent to display.

[0011] According to another particularly advantageous variant, the first, the second and the third color component values respectively correspond to a green, blue and red color values of the element in a RGB color space, a parameter of the first linear combination being a green color component multiplying factor to be applied to the green color component, a parameter of the second linear combination being a blue color component multiplying factor to be applied to the blue color component, the green color component multiplying factor being strictly higher than the blue color component multiplying factor.

[0012] According to another particularly advantageous variant, a parameter of the third linear combination is a red color component multiplying factor to be applied to the red color component, the red color component multiplying factor being strictly higher than the blue color component multiplying factor and strictly lower than the green color component multiplying factor.

[0013] According to another particularly advantageous variant, the first, the second and the third color component values respectively correspond to a green, blue and red color values of the element in a RGB color space, a parameter of the first linear combination being a first luminance multiplying factor to be applied to a luminance value of the element, and a parameter of the second linear combination being a second luminance multiplying factor to be applied to the luminance value of the element, the first luminance multiplying factor being strictly higher than the second luminance multiplying factor.

[0014] According to another particularly advantageous variant a parameter of the third linear combination is a third luminance multiplying factor to be applied to the luminance value of the element, the third luminance multiplying factor being strictly higher than the second luminance multiplying factor and strictly lower than the first luminance multiplying factor.

[0015] According to another particularly advantageous variant, the first, second and third color component multiplying factors are responsive to the human visual sensitivity to respectively the green, blue and red colors.

[0016] According to another particularly advantageous variant, the first, second and third luminance multiplying factors are responsive to the human visual sensitivity to respectively the green, blue and red colors.

[0017] According to another particularly advantageous variant, a common parameter of the first, second, and third linear combinations is a color multiplying factor and the modified first, second and third color component values are the respective sum of the color multiplying factor applied to the color component value of the element and of the respective green, blue and red color multiplying factor applied to the respective color component value of the element.

[0018] According to another particularly advantageous variant a common parameter of the first, second, and third linear combinations is a color multiplying factor and wherein the modified first, second and third color component values are the respective sum of the color multiplying factor applied to the color component value of the element and of the respective first, second and third luminance multiplying factor applied to the luminance value of the element.

[0019] According to another particularly advantageous variant the method further comprises detecting ambient lighting conditions, and wherein adapting the rendering visibility is responsive to the detected ambient lighting conditions.

[0020] According to another particularly advantageous variant, adapting the rendering visibility is configurable via a user interface.

[0021] According to another particularly advantageous variant, the modified second and modified third color component values are set to zero, resulting in a monochromatic display.

[0022] According to another particularly advantageous variant, elements are included in a region of interest of the content.

[0023] In a second aspect a device for adapting a rendering visibility of a content is also disclosed. An element of the content is represented by at least a first, a second and a third color component values. The device comprises:

- means for obtaining a modified value of a first color component and a modified value of a second color component from respectively a first and a second linear combinations of the first, the second and the third color component values, the first and the second linear combinations relatively increasing the first color component for which a human visual sensitivity is high with regards to the second color component for which the human visual sensitivity is low;
- means for adapting the rendering visibility by sending to display the modified first and second color component values;

the device being characterized in that parameters of the first and second linear combinations are independent of the first, second and third color component values.

[0024] In a third aspect a device for adapting a rendering visibility of a content is also disclosed. An element of the content is represented by at least a first, a second and a third color component values. The device at least one processor configured to:

- obtain a modified value of a first color component and a modified value of a second color component from respectively a first and a second linear combinations of the first, the second and the third color component values, the first and the second linear combinations relatively increasing the first color component for which a human visual sensitivity is high with regards to the second color component for which the human visual sensitivity is low;
- adapt the rendering visibility by sending to display the modified first and second color component values;

the device being characterized in that parameters of the first and second linear combinations are independent of the first, second and third color component values.

[0025] In a fourth aspect, a computer program product for adapting a rendering visibility of a content, wherein an element of the content is represented by at least a first, a second and a third color component values is also disclosed. The computer program product comprises program code instructions executable by a processor for performing the method implemented in any of its variant.

[0026] In a fifth aspect, a computer-readable storage medium storing computer-executable program instructions for adapting a rendering visibility of a content, wherein an element of the content is represented by at least a first, a second and a third color component values is also disclosed. The computer-readable storage medium comprises instructions of program code executable by at least one processor to perform the method implemented in any of its variant.

[0027] While not explicitly described, the present embodiments may be employed in any combination or sub-combination. For example, the present principles are not limited to the described variants, and any arrangement of variants and embodiments can be used. Moreover the present principles are not limited to the described color space and color components examples and any other type of color space and color components is compatible with the disclosed principles. The present principles are not further limited to the described linear combinations and are applicable to any other linear combinations with other parametrization, aiming at relatively increasing a color component for which a human visual sensitivity is high with regards to another color component for which the human visual sensitivity is low. The present principles are not further limited to the described content and content elements.

[0028] Besides, any characteristic, variant or embodiment described for a method is compatible with a device comprising means for processing the disclosed method, with a device comprising a processor configured to process the disclosed method, with a computer program product comprising program code instructions and with a computer-readable storage medium storing program instructions.

4. BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

- Figure 1 illustrates an example of a relative luminous efficiency function;
- Figure 2 illustrates a method for adapting a rendering visibility according to a specific and non-limiting embodiment;
- Figure 3 represents a processing device for adapting a rendering visibility according to two specific and non-limiting embodiments;
- Figure 4 represents an exemplary architecture of the processing device of figure 3 according to a specific and non-limiting embodiment.

5. DESCRIPTION OF EMBODIMENTS

[0030] The visual sensitivity of the human eye is generally represented by a luminosity function, describing the average spectral sensitivity of human visual perception of brightness.

[0031] Figure 1 illustrates an example of a relative luminous efficiency function 10. The relative luminous efficiency function, also called a luminosity function is based on subjective judgements of which of a pair of different-colored lights is brighter, to describe relative sensitivity to light of different wavelengths. The luminosity function 10 is not necessarily perfectly accurate in every case, and some people with some visual defect may slightly deviate from it, but it is a very good representation of visual sensitivity of the human eye in general. According to the luminosity function 10, the human eye has a greatest sensitivity to lights of a wavelength between 555 and 565 nano-meters, corresponding to yellow-green colors. The luminosity function is a standard function established by the CIE (Commission Internationale de l'Eclairage) and is used to convert radiant energy into luminous (i.e. visible) energy. An image displayed by a display

device is visible to humans according to a luminous energy generated by the display device.

[0032] In practice an image corresponds to a set of pixels, and displaying a pixel by a display device comprises displaying at least three subpixels respectively corresponding to at least a red, a green and a blue subpixel of the pixel. In a first example a RGB (Red Green Blue) LCD (Liquid Crystal Display) display device comprises three subpixels for each pixel, being illuminated by a common backlight for producing a visible pixel. LCD display devices equipped with local dimming are further capable to locally adjust the backlight intensity by zones according to the locally displayed pixels. Through a careful control and variation on the voltage applied, the intensity of each subpixel can range over 256 shades. Combining the subpixels produces a possible palette of 16.8 Million colors (256 shades of red x 256 shades of green x 256 shades of blue).

[0033] In a second example, a RGB LED (Light Emitting Diode) display device comprises three light emitting diodes (LED) for each pixel, for respectively producing a red, green and blue light for each pixel. Each of the red, green and blue light emitting diodes are independently adjustable so as to produce a wide range of colors.

[0034] In a third example an RGB OLED (Organic Light Emitting Diode) display device similarly produces for each pixel three independently adjustable organic sources of light corresponding to respectively a red, a green and a blue light.

[0035] In a fourth example, a display device according to any above mentioned technologies is a RGBY (Red Green Blue Yellow) display device, displaying four subpixels for each pixel, respectively producing a red, green, blue and yellow colors for each pixel. Such recent display devices are advantageously able to generate larger palettes of colors thanks to the additional yellow subpixel.

[0036] In a fifth example a display device according to any above mentioned technologies is a RGBW (Red Green Blue White) display device, displaying four subpixels for each pixel, respectively producing a red, green, blue and white colors for each pixel.

[0037] In all the above examples, by displaying a pixel, a display device generates at least three (or four) different light signals of different intensities and different wavelengths and corresponding to at least the red, green, blue (and yellow or white) component values. The synthesis of the appropriate color, resulting from the additions of the generated light signals being performed in the human brain.

[0038] RGB, RGBY, RGBW color spaces are specific examples of a more generic color space. Other color spaces are for example and without limitation a YUV or an YPrPb color space or more generally a CIEXYZ color space. In any color space of any dimension, a pixel is generally represented by a set of component values, being for example a first, a second a third (and optionally a fourth) component values.

[0039] For the sake of clarity and without loss of generality RGB, RGBY and RGBW color spaces are used for describing the disclosed principles, but any other color space is applicable to the disclosed principles by applying an appropriate transform to or from the RGB(Y/W) color space.

[0040] According to different coding schemes, an R, G, B (optionally Y/W) color value is an 8-bits or 10-bits long integer value. Whatever the coding scheme the color value of a pixel (being the color value of the corresponding sub-pixel) is representative of an intensity of light (e.g., an amount of light energy) that is emitted by the display device to display the corresponding sub-pixel in the corresponding color according to an electro optical transfer function (EOTF) related to the display device. In other words, increasing and decreasing a color component value respectively corresponds to increase and decrease an amount of light energy emitted for that color component. In the remaining of the description increasing or decreasing a value of a color component has the same effect as increasing or decreasing the amount of energy being emitted by the display device for the corresponding color component. It shall be further noted that an amount of energy being emitted by the display device for a color component may be further increased (or decreased) in the EOTF of the display device, from a same factor for all the color components.

[0041] The amount of emitted light energy is further related to a visibility of the pixel and to a power consumption of the display device for displaying the pixel. For LED and OLED display devices, the higher the color component values of a pixel or a set of pixels, the higher the power consumption for displaying the pixel or set of pixels. However, the visibility to a human of the displayed pixel or set of pixels depends on the human visual sensitivity to the wavelength of the visual signals emitted by the display device for displaying the pixel or set of pixels. Increasing (or decreasing) the color component values of a pixel or a set of pixels will not necessarily increase (or decrease) the visibility of the displayed pixel or set of pixels from a same factor as it increases (or decreases) the power consumption of the display device. A salient idea is therefore to apply a function, such as a linear combination to the color component values of a pixel or a set of pixels, relatively increasing a color component for which a human visual sensitivity is high (as for example a green and/or a yellow color component in the RGB(Y) color space) with regards to a further color component for which the human sensitivity is low (as for example the red or the blue color components in the RGB(Y) color space), the parameters of the linear combination being determined independently from the values of the color components. Indeed the parameters only depend on the color space to which the color component values refer and are applicable to the whole content or to the whole element of the content depending on the variant.

[0042] Relatively increasing on one hand the green and/or yellow (or white) color component value with regards to the red and/or the blue color component value in the other hand modifies the initial colors of the content and does not

preserve the initial creative intent of the content, but allows to increase the visibility of the pixel without increasing the power consumption of the device. The modified color components resulting from the relative increase of a color component with regards to another color component may then be optionally coupled with an overall brightness increase function and/or an automatic brightness limiter. The disclosed principles are advantageous for preserving battery life time or for further reducing the size of power supply. Indeed the disclosed principles are also applicable to devices being powered by a power supply, as they enable for example to further reduce the maximum power drained from the power supply without compromising the visibility of the displayed content. Moreover applying linear combinations with parameters determined independently from the values of the color components is advantageous as it does not require an analysis of the color component values prior determining and applying parameters of a linear combination. The color component modification remains simple and efficient.

[0043] The disclosed principles are also advantageous for LCD displays, wherein the power consumption is directly related to the backlight power consumption and to the overall brightness level of the display device. LCD display devices with for example local dimming are able to locally adjust the backlight intensity by zones according to the locally displayed pixels. Indeed, the disclosed method allows to reduce the overall brightness (and thus the power consumption of the LCD backlight), while preserving the visibility of the content by relatively increasing a color component for which a human visual sensitivity is high with regards to color components for which the human visual sensitivity is low.

[0044] Figure 2 illustrates a method for adapting a rendering visibility of a content according to a specific and non-limiting embodiment of the disclosed principles. The term "content" refers to any type of visual content being rendered on a display of any kind. A content is for example an image of any resolution corresponding to a set of pixels. In another example a content is a video comprising a plurality of images of any resolution, each image corresponding to a set of pixels. In yet another example a content is a set of videos and/or images corresponding to more immersive rendering means. In any three dimensions color space examples, an element of the content is represented by a first, a second and a third color component values in the color space. In any four dimensions color space examples, an element of the content is represented by a first, a second, a third and a fourth color component values in the color space.

[0045] The term "element" refers to any part of the content, associated with given color characteristics represented for example by at least three color component values. For example an element corresponds to a pixel in an image. In another example, the element corresponds to a set of pixels in an image with same color component values. In another example an element corresponds to an area of a displayed content, for example to display a banner or a set of icons. In yet another example an element is included in a region of interest. An element represented by more color component values than three is also compatible with the disclosed principles. In a variant, an element being a region of interest in an image, or a part of an image, or a region of an image, or even a whole image, is represented by a plurality of tuples, each tuple comprising at least a first, a second and a third color component values. In that variant the disclosed principles (i.e. modifying and sending to display the first, second, and optional third and fourth color component values) are applicable to each tuple/pixel of the element.

[0046] In the step S20, a modified first color component value is obtained from a first linear combination of at least a first, a second and a third color component values of an element of the content. A modified second color component value is further obtained from a second linear combination of at least the first, the second and the third color component values of the element of the content. Parameters of the first and the second linear combinations are determined independently of the content so as to relatively increase a first color component for which a human visual sensitivity is high with regards a second color component for which a human visual sensitivity is low. For example the first color component (for which the human visual sensitivity is high) is kept unchanged and the second color component (for which the human visual sensitivity is low) is decreased by applying a ratio.

[0047] Optionally, the method further comprises obtaining a modified third color component value, from a third linear combination of the first, second and third color component values, parameters of the third linear combination being independent from the first, second and third color component values, the third linear combination further relatively increasing the first color component (for which the human visual sensitivity is high) with regards to the second color component (for which the human visual sensitivity is low), and/or further decreasing a third color component for which the human visual sensitivity is also low.

[0048] In an optional variant, wherein the element is represented by a first, a second a third and a fourth color component values (as for example in a RGBY or RGBW color space), the modified color component values are obtained from linear combinations of the first, second, third and fourth component values, wherein the parameters of the linear combinations are independent from the color component values. The method further optionally comprises obtaining a modified fourth color component value, from a fourth linear combination of the first, second, third and fourth color component values, parameters of the fourth linear combination being independent from the first, second, third and fourth color component values, the fourth linear combination relatively increasing a fourth color component (for which the human visual sensitivity is high) and/or further relatively increasing the first color component (for which the human visual sensitivity is high) with regards to the second color component (for which the human visual sensitivity is low), and/or to a third color component for which the human visual sensitivity is also low.

[0049] The first, the second and the optional third and fourth linear combinations comprise parameters, being multiplying factors of the various color components. The multiplying factors of the first, the second and the optional third and fourth linear combinations are independent of the color component values. This means that, in any of the first, second, third or fourth linear combinations, a same multiplying factor is applied to any value of a given color component, whatever the value of the given color component. Multiplying factors of the first, the second and the optional third and fourth linear combinations are determined so as to:

- relatively increase a first color component for which the human visual sensitivity is high with regards to a second and/or a third color component for which the human visual sensitivity is low,
- optionally relatively increase a fourth color component for which a human visual sensitivity is also high with regards to the second and/or the third color component for which the human visual sensitivity is low.

For example the first and optional fourth color components (for which the human visual sensitivity is high) are kept unchanged and the second and optional third color components (for which the human visual sensitivity is low) are decreased by applying a ratio being dependant for example from the human visual sensitivity to the color component.

[0050] According to a specific and non-limiting RGB embodiment a first color component for which the human sensitivity is high is a green component of a RGB space, the human sensitivity to the green light being high. A second and a third color components for which the human sensitivity is low are for example a blue and a red components of the RGB space, the human sensitivity to the blue and red lights being lower than to the green light.

[0051] According to a specific and non-limiting RGBY embodiment, being an extension of the RGB embodiment, a fourth color component for which the human sensitivity is high is a yellow color component of a RGBY space, the human sensitivity to the yellow light being high.

[0052] Determining whether a human sensitivity to a color component is high or low, is done for example by evaluating the wavelength corresponding to the color component with regards to the luminosity function of Figure 1.

[0053] According to yet another non-limiting RGBW embodiment being also an extension of the RGB embodiment, a fourth color component for which the human sensitivity is high is a white color component of a RGBW space. It shall be noted that although each of the red, green, blue and yellow colors correspond to a particular (range) of wavelength, a white color represents an addition of all possible visible colors. By extension a white color component is however considered in the present disclosure as corresponding to a color component for which the human sensitivity is high (since a white color comprises colors for which the human sensitivity is high). The disclosed principles are not limited to the described RGB, RGBY and RGBW variants. Any color space variant with a first, second and optional third and fourth color components being functions of a set of color components are compatible with the disclosed principles.

[0054] In a first variant, corresponding to the RGB space, the first, second and optional third linear combinations respectively apply to the modification of G, B and R component values. In the first RGB variant, parameters of the first linear combination for example keep the green component unchanged, the green component being a color component for which a human visual sensitivity is high. In another example parameters of the first linear combination slightly increase or decrease the green component. (Note that in case the green component is increased, it shall only be *slightly* increased to avoid a clipping of the green component value.) Parameters of the second linear combination decrease the red or the blue component, in a larger proportion than the green component is decreased (if ever decreased) by the first linear combination, the red or the blue component being a color component for which the human visual sensitivity is low. Parameters of the optional third linear combination further decrease the blue or the red component, not being decreased by the second linear combination, the further decrease also being in a larger proportion than the green component is decreased (if ever decreased) by the first linear combination.

[0055] In a second variant, corresponding to the RGBY or RGBW spaces (noted RGBY(W)), the first, second and optional third and fourth linear combinations respectively apply to the modification of G, B, R and Y (or W) component values. In the second RGBY(W) variant, parameters of the first linear combination (and optionally parameters of the fourth linear combination) for example keep the green or the yellow (white) component unchanged, the green or the yellow (or white) component, being color components for which a human visual sensitivity is high. In another example parameters of the first linear combination (and optionally parameters of the fourth linear combination) slightly decrease (or slightly increase) the green or the yellow (or white) component. Parameters of the second linear combination decrease the red or the blue component in a larger proportion than the green or the yellow (or white) component is decreased (if ever decreased) by the first linear combination, the red or the red or the blue component, being color components for which the human visual sensitivity is low. Parameters of the optional third linear combination further decrease the blue or the red component, not being decreased by the second linear combination, the further decrease also being in a larger proportion than the green component is decreased (if ever decreased) by the first linear combination.

[0056] In a third variant, corresponding to another color space wherein dimensions do not necessarily match color components, parameters of the first linear combination relatively increase a first color component for which a human visual sensitivity is high with regards to a second color component for which the human visual sensitivity is low. In that

third variant, parameters of the second linear combination further relatively increase the first color component (for which the human visual sensitivity is high), with regards to the second color component (for which the human visual sensitivity is low). In that variant parameters of both the first and the second linear combinations contribute to the relative increase of the first color component with regards to the second color component. Moreover, parameters of the first and/or the second linear combinations optionally further decrease a third color component for which the human visual sensitivity is low and optionally further relatively increase a fourth color component for which the human visual sensitivity is high with regards to the second and/or third color component.

[0057] More generally any variant comprising a first, a second, and an optional third and fourth linear combinations, wherein parameters of the first and/or the second and/or the third linear and/or the fourth combinations relatively increase a first and optionally a fourth color components for which a human visual sensitivity is high, with regards to a second color component for which the human visual sensitivity is low, and optionally with regards to a third color component for which the human visual sensitivity is also low, is compatible with the disclosed principles.

[0058] In the step S22, the rendering visibility is adapted by sending to display the modified first, second and optional third/fourth color component values. Optionally an automatic brightness limiter (ABL), possibly further boosting the component values in a same proportion, is applied to the modified first, second and optional third/fourth component values prior sending them to display. The disclosed method is indeed compatible with display devices using ABL.

[0059] Obtaining and sending to display a modified first, second (and optional third/fourth) color component values of an element from respectively a first, a second (and an optional third/fourth) linear combinations of the first, the second and the third/fourth color component values of the element, wherein the first, the second (and the optional third/fourth) linear combinations relatively increase color intensities for which the human visual sensitivity is high with regards to color intensities for which the human visual sensitivity is low, is advantageous as it preserves the visibility of the display of the element while decreasing the power consumption. When the modified color components are further globally boosted from a same factor for increasing the brightness, the visibility of the display of the element is increased without increasing the power consumption. Any combination between preserving/improving the visibility and decreasing/preserving the power consumption are compatible with the disclosed principles. The colors of the displayed element are modified and the creative intent of the content is not totally preserved, but in very bright environment the visibility of the displayed content is preserved or improved without increasing or even while decreasing the power consumption of the display device. Moreover applying linear combinations with parameters independent from the values of the color components is advantageous as it does not require an analysis of the color component values prior determining and applying parameters of a linear combination. The color component modification is simple and efficient as the parameters of the linear combinations only depend on the color components and the color space to which they correspond (the parameters do not depend on the values of the color components). In other words, the parameters of the linear combinations for modifying the color components values of the content do not depend on the content itself.

[0060] Two specific and non-limiting RGB embodiments will be described hereafter. The implementations details provided for these RGB embodiments are directly extendable and applicable to a RGBY or RGBW embodiment.

First RGB Embodiment based on color component multiplying factors.

[0061] According to a first and non-limiting embodiment of the disclosed principles, the color space is a RGB color space. The first, second and third color component values of an element are respectively the green, blue and red color component values of the element. A parameter of the first linear combination is a green color component multiplying factor (α_G) to be applied to (any value of) the green color component, a parameter of the second linear combination is a blue color component multiplying factor (α_B) to be applied to (any value of) the blue color component, the green color component multiplying factor (α_G) being strictly higher than the blue color component multiplying factor (α_B).

[0062] In an implementation example α_G is closed to one (e.g. $\alpha_G = 1$ or $\alpha_G = 0.99$, or $\alpha_G = 1.01$) so as to keep the green color component and preserve visibility. α_B is largely lower than one (e.g. $\alpha_B = 0.6$) so as to reduce the blue color component and reduce the power consumption from a larger proportion than the visibility is reduced. Optionally $\alpha_R = 0.75$ so as to also reduce the red color component and further reduce the power consumption from a further larger proportion than the visibility is reduced.

[0063] The color component values are further converted into light energy according to an electro optical transfer function (EOTF) related to the display device. The conversion into light energy may comprise for example increasing globally the brightness of the image so as to improve the visibility while preserving or maintaining the power consumption. The conversion into light energy may also comprise an automatic brightness limiter (ABL).

[0064] Note that $\alpha_G = 1$, $\alpha_B = 0.6$ and $\alpha_R = 0.75$ are exemplary values and any other set of values is compatible with the disclosed principles.

[0065] The blue color component multiplying factor (α_B) to be applied to the blue component is advantageously strictly lower than the red color component multiplying factor (α_R) to be applied to the red component as the human visual sensitivity to the blue color is lower than to the red color. Indeed a reduction of emitted energy (in the blue compared to

the red) is not translated in a similar reduction of visibility, the impact on visibility reduction being smaller than the reduction of power consumption.

[0066] The first, second and optional third linear combinations are further written below:

$$G_{out} = \alpha_G G_{in} ; B_{out} = \alpha_B B_{in} ; R_{out} = \alpha_R R_{in} ; \alpha_B < \alpha_R < \alpha_G$$

[0067] Where G_{out} , B_{out} and R_{out} , respectively are a modified first, second and third color component values; G_{in} , B_{in} and R_{in} , respectively are a first, second and third color component values.

[0068] According to an implementation example,

$$\alpha_G = \alpha + 0.587*\beta ; \alpha_B = \alpha + 0.114*\beta ; \alpha_R = \alpha + 0.299*\beta$$

where :

- α is a common color multiplying factor parameter of the first, second and third linear combinations, and represents a ratio of the initial color component that is to be preserved throughout the color component values modifications. α being a ratio is comprised between zero and one. A typical value for α is 0.5
- 0.299, 0.587, 0.114 are coefficients responsive to the human visual sensitivity to respectively the red, green and blue colors. These values are generally used to compute the luminance from RGB values. Other coefficient values being higher for green than for red, being higher than for blue are compatible with the disclosed principles.
- β is a further coefficient related to the desired visibility. A typical value for β is 1. β may take a value other than one, and depends on the α_G and α values. If for example $\alpha = 0.5$, and $\alpha_G = 1$ (assuming the green component value is capped to the maximum value after applying α_G and before sending to display), $\beta = (1-0.5)/0.587 = 0.85$. Any other values are compatible with the disclosed principles.

α and β allow to adjust the compromise between increasing the visibility (high value of β) and preserving the colors of the initial values (high value of α). Advantageously α and β are configurable parameters of the display device.

[0069] According to the implementation example, a modified first color component value (G_{out}), a modified second color component value (B_{out}) and an optional modified third color component value (R_{out}) are obtained from respectively a first, a second and an optional third linear combinations of the first (G_{in}), the second (B_{in}) and the third (R_{in}) color component values, wherein parameters (α_G , α_B , α_R) of the first, second and optional linear combinations are independent of first (G_{in}), the second (B_{in}) and the third (R_{in}) color component values. A parameter of the first linear combination is a green color component multiplying factor ($0.587*\beta$) to be applied to the green color component, a parameter of the second linear combination is a blue color component multiplying factor ($0.114*\beta$) to be applied to the blue color component, the blue color component multiplying factor ($0.114*\beta$) being strictly lower than the green color component multiplying factor ($0.587*\beta$). A parameter of the optional third linear combination is a red color component multiplying factor ($0.299*\beta$) to be applied to the red color component, the red color component multiplying factor ($0.299*\beta$) being strictly higher than the blue color component multiplying factor ($0.114*\beta$) and strictly lower than the green color component multiplying factor ($0.587*\beta$).

[0070] Advantageously the green ($0.587*\beta$), blue ($0.114*\beta$) and red ($0.299*\beta$) color component multiplying factors are responsive to the human visual sensitivity to respectively the green, blue and red colors, as they include a coefficient (0.587, 0.114, 0.299) representative of the visual sensitivity to respectively the green, blue and red, colors. The values 0.587, 0.114, 0.299 are non-limiting examples and any coefficient values representative of the visual sensitivity to respectively the red, green and blue colors are compatible with the disclosed principles.

[0071] A common parameter (α) of the first, second, and third linear combinations is a common color multiplying factor (α). The modified first (G_{out}), second (B_{out}) and third (R_{out}) color component values are the respective sum of the common color multiplying factor (α) applied to the color component value of the element and of the respective green ($0.587*\beta$), blue ($0.114*\beta$) and red ($0.299*\beta$) color multiplying factor applied to the respective color component value of the element.

[0072] The first RGB embodiment is advantageously simple and efficient as it involves a single multiplying factor to be applied to a (green, blue, red) color component to obtain a modified (green, blue, red) color component, whatever the value of the color component.

Second RGB Embodiment based on luminance multiplying factors.

[0073] According to a second and non-limiting embodiment of the disclosed principles, the color space is also a RGB color space, the first, second and third color component values of an element being respectively the green, blue and red color component values of the element. A parameter of the first linear combination is a first luminance multiplying factor (β_G) to be applied to a luminance value (Y_{in}) of the element, a parameter of the second linear combination is a second luminance multiplying factor (β_B) to be applied to the luminance value (Y_{in}) of the element, the first luminance multiplying factor (β_G) being strictly higher than the second luminance multiplying factor (β_R). A parameter of the optional third linear combination is a third luminance multiplying factor (β_R) to be applied to the luminance value (Y_{in}) of the element, the third luminance multiplying factor (β_R) being strictly higher than the second luminance multiplying factor (β_B) and strictly lower than the first luminance multiplying factor (β_G). The first, second and optional third linear combinations are further written below:

$$G_{out} = \alpha G_{in} + \beta_G Y_{in} ; B_{out} = \alpha B_{in} + \beta_B Y_{in} ; R_{out} = \alpha R_{in} + \beta_R Y_{in}$$

$$\text{With } Y_{in} = 0.299 \cdot R_{in} + 0.587 \cdot G_{in} + 0.114 \cdot B_{in} \text{ and } \beta_B < \beta_R < \beta_G$$

[0074] Advantageously, the first (β_G), second (β_B) and third (β_R) luminance multiplying factors are responsive to the human visual sensitivity to respectively the green, blue and red colors. For example $\beta_G = 0.587 \cdot \beta$, $\beta_B = 0.114 \cdot \beta$ and $\beta_R = 0.299 \cdot \beta$; in another example $\beta_G = 0.7122 \cdot \beta$, $\beta_B = 0.0722 \cdot \beta$ and $\beta_R = 0.2126 \cdot \beta$, where β is a common coefficient.

[0075] In an advantageous variant, a common parameter of the first, second, and third linear combinations is a color multiplying factor (α). The modified first (G_{out}), second (B_{out}) and third (R_{out}) color component values are the respective sum of the color multiplying factor (α) applied to the color component value of the element and of the respective first (β_G), second (β_B) and third (β_R) luminance multiplying factor applied to the luminance value (Y_{in}) of the element.

[0076] As for the first embodiment, α and β are common coefficients to all the linear combinations, and allow to adjust the compromise between increasing the visibility (high value of β) and preserving the initial colors (high value of α). Advantageously α and β are configurable parameters of the display device. α corresponds to a ratio of initial color values that are kept throughout the modification.

[0077] In a particularly advantageous variant, the modified second and third color components are set to zero, resulting in a monochromatic display, concentrating all the energy in the most visible color component. This variant is advantageous for example in particularly bright viewing conditions where a best compromise between visibility and power consumption is expected from the display device, without looking forward preserving the initial colors or artistic intent.

[0078] The first and the second RGB embodiments describe two different examples of obtaining a modified green (G_{out}), blue (B_{out}) and optional red (R_{out}) color component values from respectively a first, a second and an optional third linear combinations of a green (G_{in}), blue (B_{in}) and red (R_{in}) color component values, the green color component value (G_{out}) remains relatively unchanged, for preserving visibility, the modified blue and/or red color component values (B_{out} , R_{out}) being smaller than the respective blue and/or red color component value (B_{in} , R_{in}), so as to decrease the power consumption of the display device at a preserved visibility. The visibility is further advantageously increased for a preserved power consumption by increasing globally the brightness of the element (by applying a same amplification factor to all the color components prior to display).

[0079] The second RGB embodiment although being slightly more complex than the first RGB embodiment advantageously provides a more robust content visibility adaptation approach. By using luminance multiplying factors, the visibility increase does not depend on the statistics of the colors of the image. An image for example having only few gradients of the green color would be more visible via the modification of the second embodiment than the first embodiment.

[0080] In advantageous variant, the method further comprises detecting ambient lighting conditions, for example via a sensor of the display device, configured to measure a level of ambient lighting. According to the variant, adapting the rendering visibility is responsive to the detected ambient lighting conditions. For example, in case the measured level of ambient lighting is under a first level, the first, second and optional third and fourth color component values of the element are not modified. In case the measured level of ambient lighting is above a second level, the first, second and optional third and fourth color component values of the element are modified according to any described variant and/or embodiment. The first and second level may be a same value, or different values so as to implement a hysteresis mechanism.

[0081] In another advantageous variant, adapting the rendering visibility is configurable via a user interface of the display device. For example the rendering visibility is configurable in automatic mode, wherein the rendering visibility is responsive to detected ambient lighting conditions. In another example, the rendering visibility is configurable in manual

mode, comprising at least an on and off modes. When configured in off mode, the first, second and optional third and fourth color component values of the element are sent to display without being modified in step S20. When configured in on mode, the first, second and optional third and fourth color component values of the element are modified according to the disclosed principles in any of the described variant and/or embodiment, and independently from any ambient lighting conditions, and sent to display. In yet another example a monochromatic display mode as previously described, is further configurable via the user interface. In yet another example some parameters of the adaptation method are configurable via the user interface. User configurable parameters are for example the common coefficients (α and β) to the linear combinations allowing to adjust the compromise between increasing the visibility (high value of β) and preserving the initial colors (high value of α).

[0082] In yet another advantageous variant, adapting the rendering visibility is applied to a region of interest of the content. A region of interest is determined according to for example a visual attention model, a saliency map being extracted from the content based on the visual attention model, and a region of interest being determined based on the saliency map. In another example the region of interest corresponds to predefined icons being displayed on an image. Any method for determining a region of interest is compatible with the disclosed principles. According to the variant, the rendering visibility is adapted for elements belonging to the determined region of interest. More drastic color component value decrease are advantageously applied to elements outside the region of interest.

[0083] Figure 3 depicts a processing device 3 for adapting a rendering visibility of a content, wherein an element of the content is represented by at least a first, a second and a third color component values.

[0084] According to a specific and non-limitative embodiment of the invention, the processing device 3 comprises an input 30 configured to receive the content which is obtained from a source, wherein an element of the content is represented by at least a first, a second and a third color component values. According to different embodiments of the disclosed principles, the source belongs to a set comprising:

- a local memory, e.g. a video memory, a RAM, a flash memory, a SSD, a hard disk ;
- a storage interface, e.g. an interface with a mass storage, a ROM, an optical disc or a magnetic support;
- a communication interface, e.g. a wireline interface (for example a bus interface, a wide area network interface, a local area network interface) or a wireless interface (such as a IEEE 802.11 interface, a Bluetooth interface or a cellular network interface);

[0085] The processing device 3 further comprises an optional input 31 to receive configuration data from a user. Configuration data are generated by a user via a user interface in order to configure the processing device 3. According to different embodiments of the disclosed principles, the user interface belongs to a set comprising:

- a touch screen and its accompanying controller based firmware to generate configuration data;
- a keyboard;
- a network interface wherein the user interface is displayed on a remote device and the configuration data are received from the network interface.

[0086] More generally any user interface allowing to provide configuration data is compatible with disclosed principles.

[0087] The processing device 3 further comprises an optional light detector 32 configured to receive and measure a level of ambient lighting from an ambient environment. Any light detector capable to detect and measure an amount of ambient lighting is compatible with the disclosed principles.

[0088] The inputs 30 and 31 and the optional light detector 32 are linked to a processing module 34 configured to obtain a modified first color component value and a modified second color component value from respectively a first and a second linear combinations of the first, the second and the third color component values, the first and the second linear combinations relatively increasing a first color component for which a human visual sensitivity is high with regards to a second color component for which the human visual sensitivity is low. The processing module 34 is further configured to adapt the rendering visibility by sending to a display mean 38, the modified first and second color component values.

[0089] According to different embodiments of the disclosed principles, the display mean 38 belongs to a set comprising:

- a LCD display screen;
- a LED display screen;
- an OLED display surface.

[0090] More generally any display mean allowing to display a subset of the dialog items, is compatible with the disclosed principles.

[0091] Figure 4 represents an exemplary architecture of the processing device 3 according to a specific and non-limiting embodiment, where the processing device 3 is configured to adapt a rendering visibility of a content. The process-

ing device 3 comprises one or more processor(s) 410, which is(are), for example, a CPU, a GPU and/or a DSP (English acronym of Digital Signal Processor), along with internal memory 420 (e.g. RAM, ROM, EPROM). The processing device 3 comprises one or several Input/Output interface(s) 430 adapted to send to display output information and/or to allow a user to enter commands and/or data (e.g. a keyboard, a mouse, a touchpad, a webcam, a display), and/or to send /

5 receive data over a network interface; and a power source 440 which may be external to the processing device 3.
[0092] According to an exemplary and non-limiting embodiment, the processing device 3 further comprises a computer program stored in the memory 420. The computer program comprises instructions which, when executed by the processing device 3, in particular by the processor 410, make the processing device 3 carry out the processing method described with reference to figure 2. According to a variant, the computer program is stored externally to the processing device 3
 10 on a non-transitory digital data support, e.g. on an external storage medium such as a SD Card, HDD, CD-ROM, DVD, a read-only and/or DVD drive and/or a DVD Read/Write drive, all known in the art. The processing device 3 thus comprises an interface to read the computer program. Further, the processing device 3 could access one or more Universal Serial Bus (USB)-type storage devices (e.g., "memory sticks.") through corresponding USB ports (not shown).

According to exemplary and non-limiting embodiments, the processing device 3 is a display device to be used in a bright
 15 environment (possibly outdoor but not limited to out-door environments), which belongs to a set comprising:

- a smartphone;
- a tablet;
- a tablet computer;
- 20 - a laptop computer;
- a see-through display device ;
- a desktop computer display;
- a TV.

25 Claims

1. A method for adapting a rendering visibility of a content, wherein an element of the content is represented by at least a first, a second and a third color component values, the method comprising:

- 30 - obtaining (S20) a modified value of a first color component and a modified value of a second color component from respectively a first and a second linear combinations of the first, the second and the third color component values, the first and the second linear combinations relatively increasing the first color component for which a human visual sensitivity is high with regards to the second color component for which the human visual sensitivity
 35 is low;
 - adapting the rendering visibility by sending (S22) to display the modified first and second color component values;

the method being **characterized in that** parameters of the first and second linear combinations are independent of
 40 the first, second and third color component values.

2. The method according to claim 1, further comprising obtaining a modified value of a third color component, from a third linear combination of the first, second and third color component values, parameters of the third linear combination being independent from the first, second and third color component values, the third linear combination
 45 decreasing the third color component for which the human visual sensitivity is low, the modified third color component value being further sent to display.

3. The method according to claim 1, wherein the first, the second and the third color component values respectively correspond to a green, blue and red color values of the element in a RGB color space, a parameter of the first linear combination being a green color component multiplying factor, a parameter of the second linear combination being
 50 a blue color component multiplying factor, the green color component multiplying factor being strictly higher than the blue color component multiplying factor.

4. The method according to claim 2 and claim 3, wherein a parameter of the third linear combination is a red color component multiplying factor, the red color component multiplying factor being strictly higher than the blue color component multiplying factor and strictly lower than the green color component multiplying factor.
 55

5. The method according to claim 1, wherein the first, the second and the third color component values respectively

correspond to a green, blue and red color values of the element in a RGB color space, a parameter of the first linear combination being a first luminance multiplying factor and a parameter of the second linear combination being a second luminance multiplying factor, the first luminance multiplying factor being strictly higher than the second luminance multiplying factor.

6. The method according to claim 2 and claim 5, wherein a parameter of the third linear combination is a third luminance multiplying factor, the third luminance multiplying factor being strictly higher than the second luminance multiplying factor and strictly lower than the first luminance multiplying factor.

7. The method according to claim 4, wherein the first, second and third color component multiplying factors are responsive to the human visual sensitivity to respectively the green, blue and red colors.

8. The method according to claim 7, wherein a common parameter of the first, second, and third linear combinations is a color multiplying factor and wherein the modified first, second and third color component values are the respective sum of the color multiplying factor applied to the color component value of the element and of the respective green, blue and red color multiplying factor applied to the respective color component value of the element.

9. The method according to any of claims 1 to 8, further comprising detecting ambient lighting conditions, and wherein adapting the rendering visibility is responsive to the detected ambient lighting conditions.

10. The method according to any of claims 1 to 9, wherein adapting the rendering visibility is configurable via a user interface.

11. The method according to any of claims 2 to 10, wherein the modified second and modified third color component values are set to zero, resulting in a monochromatic display.

12. The method according to any of claims 1 to 11 wherein elements are included in a region of interest of the content.

13. A device for adapting a rendering visibility of a content, wherein an element of the content is represented by at least a first, a second and a third color component values, the device comprising:

- means for obtaining a modified value of a first color component and a modified value of a second color component from respectively a first and a second linear combinations of the first, the second and the third color component values, the first and the second linear combinations relatively increasing the first color component for which a human visual sensitivity is high with regards to the second color component for which the human visual sensitivity is low;

- means for adapting the rendering visibility by sending to display the modified first and second color component values;

the device being **characterized in that** parameters of the first and second linear combinations are independent of the first, second and third color component values.

14. The device according to claim 13, wherein the first, the second and the third color component values respectively correspond to a green, blue and red color values of the element in a RGB color space, a parameter of the first linear combination being a green color component multiplying factor, a parameter of the second linear combination being a blue color component multiplying factor, the green color component multiplying factor being strictly higher than the blue color component multiplying factor.

15. A computer program product for adapting a rendering visibility of a content, wherein an element of the content is represented by at least a first, a second and a third color component values, the computer program product comprising program code instructions executable by a processor for:

- obtaining a modified value of a first color component value and a modified value of a second color component value from respectively a first and a second linear combinations of the first, the second and the third color component values, the first and the second linear combinations relatively increasing a the first color component for which a human visual sensitivity is high with regards to the second color component for which the human visual sensitivity is low;

- adapting the rendering visibility by sending to display the modified first and second color component values;

EP 3 382 685 A1

the computer program product being **characterized in that** parameters of the first and second linear combinations are independent of the first, second and third color component values.

5

10

15

20

25

30

35

40

45

50

55

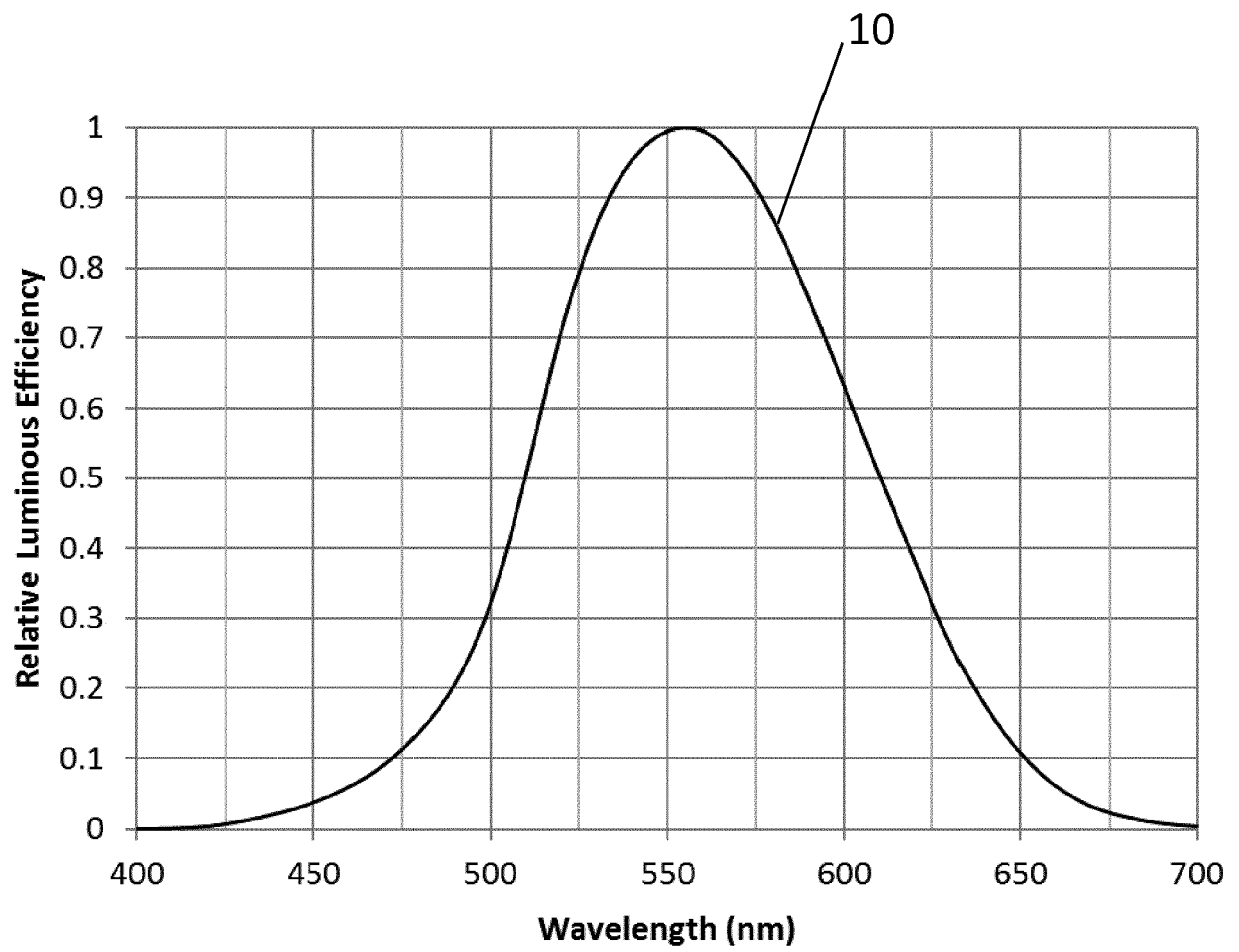


Figure 1

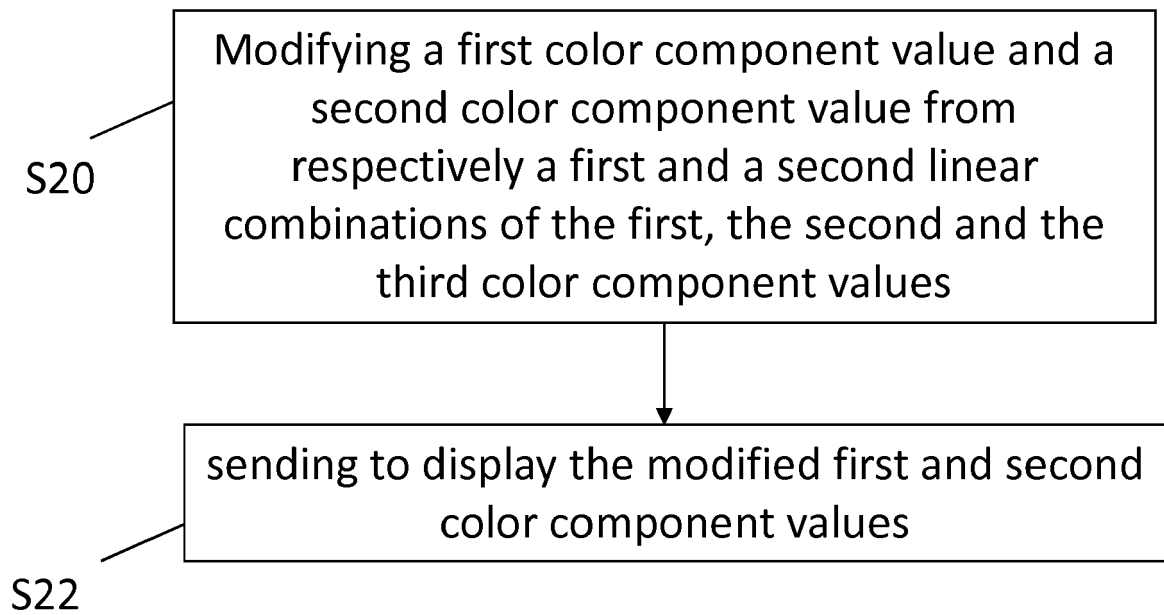


Figure 2

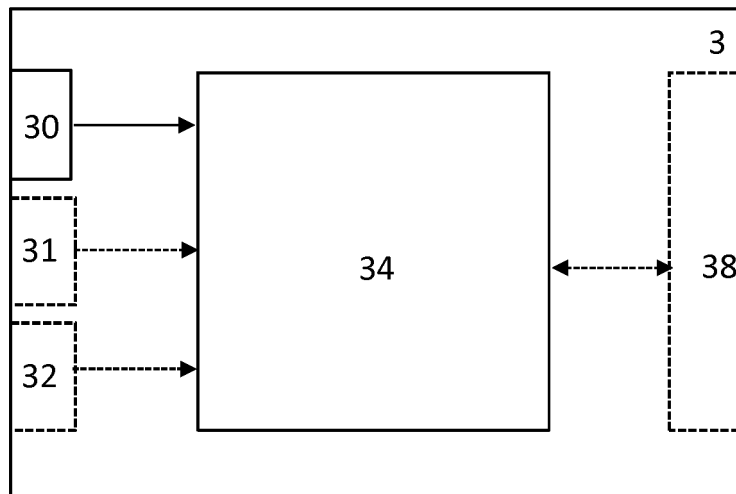


Figure 3

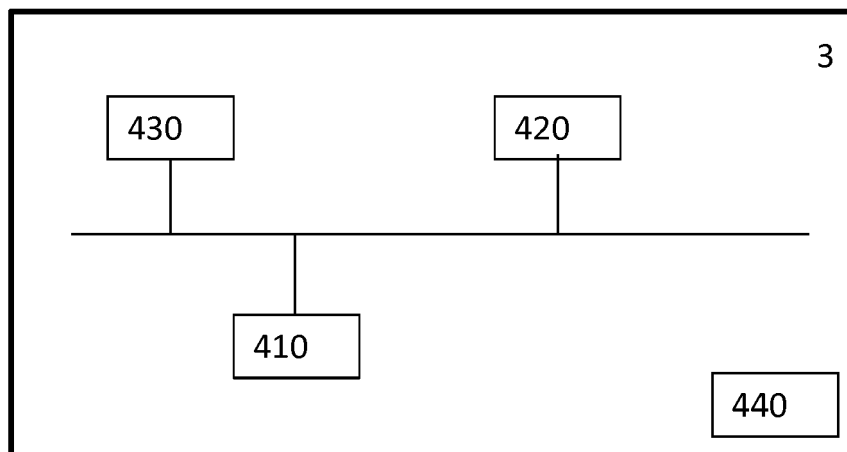


Figure 4



EUROPEAN SEARCH REPORT

Application Number
EP 17 30 5392

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/174723 A1 (DE VAAN ADRIANUS JOHANNES STEPANUS [NL] ET AL) 9 July 2009 (2009-07-09) * paragraphs [0001], [0011], [0017] - [0018], [0035], [0045], [0061], [0064]; figure 1a; table 2b *	1-8,10, 13-15	INV. G09G3/3208 G09G3/22 G09G3/20
X	KR 2013 0037538 A (LG DISPLAY CO LTD [KR]) 16 April 2013 (2013-04-16) * paragraphs [0001], [0042] - [0044], [0048] - [0049]; figure 4 *	1-8, 10-15	
X	US 2015/145839 A1 (HACK MICHAEL [US] ET AL) 28 May 2015 (2015-05-28) * paragraphs [0017], [0044] - [0052] *	1-15	
X	US 2003/222866 A1 (FUNSTON DAVID L [US] ET AL) 4 December 2003 (2003-12-04) * paragraph [0043]; figures 6a,6b *	1,11,13, 15	
			TECHNICAL FIELDS SEARCHED (IPC)
			G09G
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 8 June 2017	Examiner Ladiray, Olivier
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 30 5392

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

08-06-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009174723 A1	09-07-2009	CN 1957392 A	02-05-2007
		EP 1754218 A1	21-02-2007
		JP 2008500575 A	10-01-2008
		KR 20070027555 A	09-03-2007
		TW 200608808 A	01-03-2006
		US 2009174723 A1	09-07-2009
		WO 2005116981 A1	08-12-2005

KR 20130037538 A	16-04-2013	NONE	

US 2015145839 A1	28-05-2015	NONE	

US 2003222866 A1	04-12-2003	EP 1367559 A2	03-12-2003
		JP 2004046125 A	12-02-2004
		US 2003222866 A1	04-12-2003

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20150187331 A [0004]