

(19)



(11)

EP 2 871 635 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.05.2015 Bulletin 2015/20

(51) Int Cl.:
G09G 5/28 (2006.01)
G09G 3/00 (2006.01)
G09G 3/34 (2006.01)

(21) Application number: **13275283.3**

(22) Date of filing: **08.11.2013**

(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

(72) Inventor: **The designation of the inventor has not yet been filed**

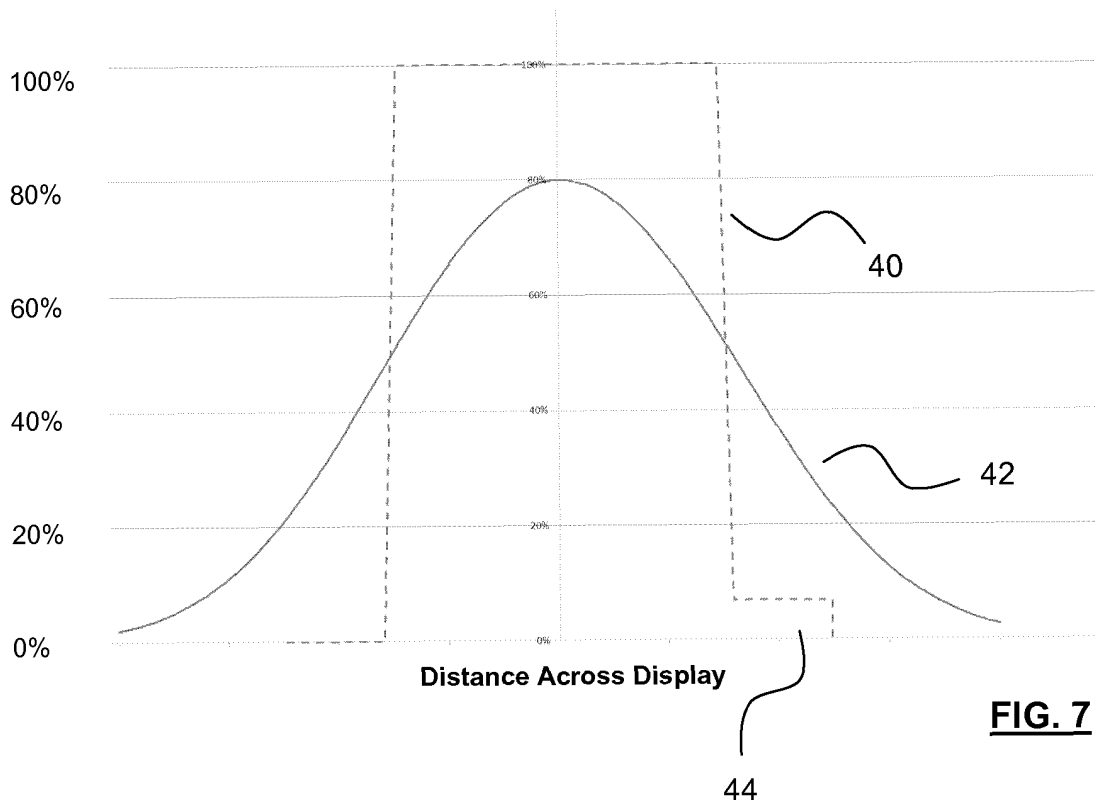
(74) Representative: **BAE SYSTEMS plc**
Group IP Department
Farnborough Aerospace Centre
Farnborough
Hampshire GU14 6YU (GB)

(71) Applicant: **BAE Systems PLC**
London SW1Y 5AD (GB)

(54) **A compensation method for a display apparatus**

(57) According to a first aspect of the invention, there is provided a compensation method for a display apparatus, the display apparatus being capable of processing input content having an input resolution to display the content with a display resolution at a display screen, the processing being such that, without compensation, for a region of the display screen the content display resolution

is lower than the content input resolution, resulting in a reduction in a contrast ratio for display content in that region, the method comprising: at least partially compensating for the reduction in contrast ratio in advance, by decreasing the input resolution of the input content for display at the region.

**FIG. 7****EP 2 871 635 A1**

Description

[0001] The present invention relates generally to a compensation method for a display apparatus, and to a display apparatus which utilises such a method.

[0002] When displaying content on a display screen, the contrast ratio of display content is important. This is because a low contrast ratio for the display content may result in it being difficult or impossible for the user of the display to easily see the content, or to understand the content in any meaningful way. This is true of perhaps all display devices. However, the problem is particularly relevant to display apparatus that provide display content on a display screen that is at least partially transparent, for example a combiner of a head up display apparatus. The problem is particularly prevalent in such applications because of the partially transparent nature of the display screen. This means that the contrast ratio of a display content is not set relative to a background level that is in some way controllable, but is instead dictated by the surrounding ambient light conditions.

[0003] If, for whatever reason, the contrast ratio is reduced at one or more regions of a display screen due to processing of the content to be displayed on that screen, then use of a display screen is adversely affected. It is desirable to have a contrast ratio and/or output luminance that varies as little as possible across the display screen, to improve the viewing experience of the user.

[0004] It is an example aim of example embodiment of the present invention to at least partially obviate or mitigate one or more problems of the prior art, whether identified herein or elsewhere, or to provide an alternative to existing methods and/or apparatus.

[0005] According to the present invention there is provided an apparatus and method as set forth in the appended claims. Other features of the invention will be apparent from the dependent claims, and the description which follows.

[0006] According to a first aspect of the invention, there is provided a compensation method for a display apparatus, the display apparatus being capable of processing input content having an input resolution to display the content with a display resolution at a display screen, the processing being such that, without compensation, for a region of the display screen the content display resolution is lower than the content input resolution, resulting in a reduction in a contrast ratio for display content in that region, the method comprising: at least partially compensating for the reduction in contrast ratio in advance, by decreasing the input resolution of the input content for display at the region.

[0007] The processing may comprise optical processing, and/or signal processing. Optical processing might comprise reflection, refraction, or diffraction, amongst other optical manipulations.

[0008] The at least partial compensation may comprise adjusting an input signal used in the generation and/or display of the content. For example, the adjusting may

comprise using more pixels to display content, or pixels at different output luminances.

[0009] Display content may be subjected to an anti-aliasing function prior to display at the display screen.

5 The anti-aliasing function may be used to decrease the resolution of the content.

[0010] The decrease in contrast may comprise a decrease in luminance of the display content, and/or the decrease in input resolution of the input content may result in an increase in luminance of the display content.

10 **[0011]** The content display resolution at the region may be lower than content display resolution at another, different region of the display screen, for example for the same input display content displayed at the different regions.

15 **[0012]** The at least partial compensation might comprise ensuring that a contrast ratio between a display content luminance and a background luminance is at or above 1.2:1 (sometime referred to simply as 1.2).

20 **[0013]** The display screen may be at least partially transparent.

[0014] The background luminance may be a luminance visible to a user through the/an at least partially transparent display screen.

25 **[0015]** The at least partial compensation might additionally comprise increasing an output luminance of a display source.

[0016] The at least partial compensation may comprise increasing an output luminance of a display source (e.g. one or more emissive light sources), such that the decrease in the input resolution of the input content for display at the region, together with the increase in luminance of the display source, ensures that a contrast ratio between a display content luminance and a background luminance is at or above 1.2:1.

30 **[0017]** The at least partial compensation might comprise one or more of: increasing a dimension, increasing a size, increasing a line-width, or increasing a scale of the display content for the region.

35 **[0018]** The method might comprise determining whether, and/or to what extent, the content display resolution is lower than the content input resolution for the region of the display, by one or more of modelling and measurement, in advance of implementing the at least partial compensation.

40 **[0019]** The display screen may be at least partially transparent, and/or comprise a combiner.

[0020] The display apparatus may be, or may form at least a part of, a head up display.

45 **[0021]** According to a second aspect of the invention, there is provided a display apparatus capable of processing input content having an input resolution to display the content with a display resolution at a display screen, the processing being such that, without compensation, for a region of the display screen the content display resolution is lower than the content input resolution, resulting in a reduction in a contrast ratio for display content in that region, the display apparatus comprising or being in con-

nection with a controller arranged to at least partially compensate for the reduction in contrast ratio in advance, by decreasing the input resolution of the input content.

[0022] The display screen may be at least partially transparent, and/or comprise a combiner.

[0023] The display apparatus may be, or may form at least a part of, a head up display (which includes a head or helmet mounted display).

[0024] It will be clear to the skilled person that one or more features of one or more aspects or embodiments of the invention may be used in place of, and/or in combination with, one or more features of one or more other aspects or embodiments of the invention, unless such combination/replacement would be understood by the skilled person as being mutually exclusive.

[0025] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic Figures in which:

Figure 1 schematically depicts a schematic view of a head up display apparatus;

Figure 2 is a graph schematically depicting optical properties of the display apparatus of Figure 1 when outputting a flat field;

Figure 3 is a graph schematically depicting optical properties of display content displayed at a centre of the display screen of Figure 1;

Figure 4 is a graph schematically depicting optical properties of display content displayed toward an outer edge of the display screen of Figure 1;

Figure 5 is another graph schematically depicting optical properties of the display apparatus of Figure 1 for flat field output and the output of display content in the form of symbols;

Figure 6 is a graph schematically depicting optical properties of display content displayed at a centre of the display screen of Figure 1;

Figure 7 is a graph schematically depicting optical properties of display content displayed toward an outer edge of the display screen of Figure 1 in accordance with an example embodiment; and

Figure 8 schematically depicts optical properties of the display apparatus of Figure 1 for both flat field output and output in the form of display content comprising symbols, in accordance with methodology of an example embodiment.

[0026] Figure 1 schematically depicts a head up display apparatus. The apparatus comprises a display source 2, for example a pixelated display source. The

display source 2 may be pixelated in terms of its light sources and/or elements used in the filtering of one or more light sources. For instance, the pixelation might be due to the display source 2 being a pixelated emissive display source, or to more passive devices that need a light source such as a light emitting diode located behind a liquid crystal shutter/filter. For instance, a light source may be in some way pixelated using one or more mirrors, liquid crystal elements, and so on.

[0027] Emitted light 4 is in some way processed 6 before being projected on to or in some other way provided at a display screen 8.

[0028] The processing 6 typically comprises optical processing, for example in some way conditioning the output light for using one or more mirrors, prisms, lens arrangements and so on. The processing might also and/or alternatively comprise signal processing in software and/or hardware (e.g. image processing).

[0029] In this example, the optical processing 6 is typically such that the light projected on to or in some way output at the display screen 8 is collimated in nature, allowing for easy viewing by a user of the display apparatus.

[0030] The display screen 8 is at least partially transparent in nature, for example being or forming a combiner. This allows display content to be provided on the display screen 8, while at the same time allowing the user to view a background through the semi transparent display screen 8. For instance, the background might be the environment in which the display apparatus is used. This allows symbology to be overlaid over a real world view.

[0031] It is desirable that luminance of display content provided at the display screen 8 is as uniform as possible across the display screen 8. This is because local reductions, resulting in reductions in contrast ratio, could lead to display content in the region of the reduction becoming difficult to discern against a bright background.

[0032] Figure 2 is a graph schematically depicting optical properties of the apparatus of Figure 1. The graph depicts a background luminance 10, and a flat field output luminance 12, both across the field of view of the display screen of Figure 1. The graph of Figure 2 also shows a contrast ratio 14 across that field of view.

[0033] It can be seen that the flat field luminance 12, and thus the contrast ratio 14, varies across the field of view. This variation is due to the processing of the light. The variation is such that the contrast ratio falls from 1.25:1 (sometimes referred to simply as 1.25) at the centre of the display to 1.20:1 at the edge of the field of view of the display. However, this variation in contrast ratio 14 might still be acceptable, since a contrast ratio of 1.2:1 is typically deemed acceptable as a lower limit for display content contrast in daylight.

[0034] Figure 2 shows the situation with flat field output luminance 12. However, the resolution of displayed content must also be considered when considering the contrast ratio properties. In particular, the effect of intentional or inadvertent compromises in the design of the optical

processing of Figure 1 on the displayed resolution of content on the display screen might have an adverse impact on the contrast ratio of displayed content. Such compromises are usually qualified or quantified using parameters such as the modulation transfer function (MTF) for a sinusoidal input or contrast transfer function (CTF) for a square wave input. For a pixelated display source, contrast transfer function is usually taken to be the most appropriate parameter for consideration. The contrast transfer function is the magnitude response of the processing of the light (e.g. optical processing) to a square wave input of different spatial frequencies.

[0035] Compromises in the design of the optical processing of the display apparatus can result in variations in the contrast transfer function across the field of view of the display screen. These variations might typically result in a display screen which appears less sharp at the edges of the field of view than at the centre of the display screen, although variations could also occur elsewhere at the screen. Figures 3 and 4 schematically depict example effects of variations.

[0036] Figure 3 is a graph schematically depicting input content in the form of a two-pixel-wide line 20 for display at the centre of the display screen. The associated output luminance profile 22 is shown. It can already be seen that the peak luminance has been reduced to 80% of that for a flat field output.

[0037] Figure 4 shows the same input two-pixel-wide line 20, but for display at the edge of the display screen. The display luminance profile 24 is shown. It can be seen that at the edge of the field of view of the display screen, the peak luminance has been reduced to 60% of that for a flat field. Also, it can be seen that the luminance profile 24 as a whole is far flatter than for the same display content when displayed at the centre of the display screen as shown in Figure 3.

[0038] An overall result is that the reduction in luminance of display content toward the edge of the display screen results in further degradation of the contrast ratio, and also a reduction in resolution, of the display content, in comparison with the input resolution and/or in comparison with the resolution of the same content displayed at other regions of the display screen.

[0039] Figure 5 is a graph depicting an overall view of optical properties of the display screen for flat field output and more specific display content output. As with the graph of Figure 2, the same background luminance level 10 is shown, as is the flat field displayed output luminance 12. In addition in Figure 5, the variation in output luminance for more specific display content 30 is also shown as varying across the field of view. The variation is such that the contrast ratio of the more specific display content (e.g. symbology) varies far more than the contrast ratio for flat field output as already shown in Figure 2. This is to the extent that only display content at the centre of field of view achieves what could be classed as a minimum requirement of 1.2:1 in terms of contrast ratio, with the contrast ratio at the edge of the field of view falling

to as low as 1.12:1.

[0040] It may thus be very difficult for a user to view display content (e.g. symbology) at the edge of the display screen.

[0041] It is of course desirable to attempt to at least partially compensate for the variations in luminance and contrast ratio. For instance, it is desirable to compensate to the extent that the contrast ratio does not fall below a minimum, threshold value, below which it might be difficult to perceive display content on the display screen. For instance, this minimum, threshold value might be the contrast ratio of 1.2:1 already discussed above, or a luminance required to achieve that ratio.

[0042] The conventional approach to providing such compensation would typically be to simply increase the luminance of the displayed content by, for example, increasing the output luminance at the display source, for example increasing LED drive current or similar. This solution, however simple, might indeed provide the required compensation. However, the compensation itself then has associated drawbacks. For instance, and with reference to Figure 5, to achieve a minimum contrast ratio of 1.20:1 at the edge of the display would require a 67% increase in the overall display luminance. This is clearly a significant increase, which would clearly require a significant increase in power consumption for the display apparatus. Perhaps more importantly, the increase power consumption would also require an associated power dissipation increase, with resultant increase in equipment temperatures (e.g. screen temperatures). This increase in temperature could cause reliability issues and other problems, for example in the case of head up displays such as helmet mounted displays, where it might be difficult to easily dissipate such power while maintaining practical functionality for the apparatus, for example a lightweight yet cost-effective construction.

[0043] According to an example embodiment, one or more disadvantages described above may be obviated or mitigated.

[0044] A compensation method is provided for a display apparatus. As already discussed above, the display apparatus is typically capable of processing input content having an input resolution to display the content with a display resolution at a display screen. The processing (for example optical or signal) is such that, without compensation, for a region of the display screen the content display resolution is lower than the content input resolution. That is, there is resolution loss from input to output. Alternatively and/or additionally, the processing is such that the content display resolution at the region of the display screen is lower than content display resolution at another, different region of the display screen. For example, there are resolution differences between display content displayed at the centre of the display screen and toward the edge of the display screen, or generally between different regions of the screen. The reduction in resolution results in a reduction in a contrast ratio for display content in that region, for example as already

shown in and described with reference to Figure 4, above. The compensation method according to an embodiment comprises at least partially compensating for the reduction in contrast ratio in advance - i.e. before the content is processed, and the reduction in contrast ratio is introduced by the processing. The at least partial compensation comprises decreasing the input resolution of the input content for display at the region of concern. In general, the decrease in the input resolution of the input content results in an overall increase in the output luminance for that content, and thus an increase in contrast ratio. The decrease in input resolution may be achieved, or further defined, or alternately defined as or by one or more of the following: increasing a dimension, increasing a size, increasing a line width, or increasing a scale of the display content in or for that region. In particular, the decrease in resolution for the display content might correspond to where on the screen the modulation transfer function or the contrast transfer function is also found, determined or detected to decrease.

[0045] Example embodiments might be described as somewhat counter-intuitive. For instance, when it is difficult to view content due to the reduction in contrast ratio and resolution and as referenced in Figure 4, the solution is to decrease the resolution of the input content. It is not at all obvious that a decrease in the resolution of the input content actually solves the problem that is directly associated with a decrease in resolution of the displayed content. For example, it might be expected that the input resolution (e.g. line width) should actually be increased in areas where display resolution has been found to decrease, so as to provide the appearance of more constant resolution (e.g. thickness of lines or size) of display content across the display screen. However, and as might now be apparent from an understanding of Figures 3 and 4, such an increase in the input resolution would in fact lead to a further decrease of the peak output luminance, and a further degradation in contrast ratio. The present invention avoids this issue in a simple but effective way.

[0046] An example implementation of the present invention will now be described with reference to Figures 6 to 8.

[0047] Figure 6 shows the same graph as already shown in and described with reference to Figure 3. A two-pixel-wide line 20 forms the input display content, and the output takes the form of the luminance profile 22.

[0048] Without compensation, attempting to display the same input content toward the edge of the display screen would result in the output luminance profile already shown in and with reference to Figure 4. In other words the luminance and thus contrast ratio of the displayed content would be insufficient. Figure 7 shows how compensation can be achieved.

[0049] Referring to Figure 7, in this particular example compensation is at least partially achieved by increasing the line width (i.e. the resolution) of the line forming the input content. The line width is adjusted, and increased to be three pixels wide 40, as opposed to two pixels wide.

The increase in the number of pixels used to form the content results in an output luminance profile 42 that is far more visible to the user. This is to the extent that the peak luminance of the content displayed at the edge of the display is now the same as the peak luminance of content displayed at the centre of the display.

[0050] This decrease in resolution, which might alternatively or additionally be described as an increase in size of the input content, might be achieved by adjusting an input signal, for example a driving signal, used in the generation of the display of the content. For example, if it is known that display content X needs to be displayed in a region where compensation is required, a driving signal to the display apparatus (e.g. the source) can be adjusted to make the display content X have a lower resolution (i.e. larger size) in the region.

[0051] Such a decrease in resolution/increase in size might be achieved more easily, and/or more suitably, if the content is isolated in nature. For example, the content may be a symbol such as a letter or a number or an image, or be a line, or a dot or a shape, as opposed to forming a more complex part of a composite image or the like. A decrease in the resolution local to a region, and thus for specific content for or at that region might be more easily achieved if the feature is isolated, for example in comparison with if the decrease in resolution needed to be undertaken near or adjacent to or around features where no resolution change was required.

[0052] Referring to Figure 7, the change in size/resolution of the input content does not necessarily need to be limited to using multiple pixels at full luminance output. For instance, one or more pixels or the like could be used to provide output at a below maximum level 44, for example to finely tune the output luminance 42.

[0053] The decreasing in resolution/increasing in size of the input content can be used to make the output luminance across the display far more uniform. Also, an overall increase in display luminance can be implemented, for example to ensure that the contrast ratio across the entire display exceeds a minimum threshold value, for example 1.2:1 as discussed above. The increase in overall display luminance is far lower than would have been required without any compensation by decrease in input content resolution, for example the 67% increase described in relation to Figure 5. For instance, in accordance with an example embodiment, an overall increase in display luminance of only 25% can be used to ensure the contrast ratio now exceeds 1.2:1 across the entire field of view of the display screen, in combination with the decrease in input resolution. This is shown in the graph at Figure 8.

[0054] Figure 8 is a graph depicting optical properties of the display apparatus employing the compensation methodology as described. The same background luminance level 10 already shown in and described with reference to previous Figures is shown. The flat field output luminance level 12 is also shown, this level being 25% higher than the same indicative level as shown in and

described with reference to Figure 2, due to the 25% increase in general output luminance for the display as previously described. The output luminance level across the display is also shown for more specific display content 50, such as symbols like text, shapes, letters, numbers, lines, dots or similar. The resulting contrast ratio 52 is also shown.

[0055] Figure 8 clearly shows that, in this particular example, the increase in overall display luminance needed to achieve the required contrast ratio of 1.2:1 across the display reduces from 67% (i.e. as in conventional approaches) to only 25% (with the example embodiment). Therefore, power consumption is reduced in comparison with conventional approaches, and so is the need for power dissipation.

[0056] The method might comprise determining whether, and/or to what extent, the content display resolution is lower than the content input resolution for the region of the display, by one or more of modelling and measurement, in advance of implementing the at least partial compensation. For example, modelling might reveal where resolution and luminance variation might be expected, or measurement might show where such occurs. Measurement might comprise imaging the display screen when display example content, to see how resolution and/luminance varies from an expected resolution/luminance and/or across the display screen.

[0057] A display apparatus could be provided that has, or is in connection with, a controller for implementing the described methodology. The described methodology could be applied to existing display apparatus, to compensate as described above.

[0058] The compensation method could be selectively applied. For example, the compensation might not be required in low light conditions, and in which case decreasing resolution of some content may not be needed or beneficial. A switch (electronic, physical, or in software and so on) might be provided to allow for selective activation and deactivation of the methodology.

[0059] It will be appreciated that a change in resolution of input content may not be the same magnitude across the display screen/for content to be displayed across the display screen. The change may be different for different content/regions, and will likely be proportional to resolution and luminance variation at the display screen before such compensation is applied.

[0060] The decrease in the input resolution of the input content for display at particular region of the display screen where compensation is required can be achieved in a number of ways. For instance, the display content could be in some way scaled up or similar by taking stored display content and scaling that content and storing that content separately, or by replacement. Alternatively, the actual display content may not change in form, and the display content may be processed in some way to have its resolution decreased/its size increased before, for instance, optical processing for the display at the display screen. For instance, and in particular for pixelated dis-

plays, it is known to use an anti-aliasing function. The anti-aliasing function is applied to the display content prior to display at the display screen, for example to smooth edges of the display content. The properties of the anti-aliasing function may be taken advantage of in example embodiments, by providing a convenient way for decreasing the resolution of the display content/increasing its size, for example in a way at least similar to that shown in Figure 7.

[0061] It will be appreciated that the exact percentages described above in relation to the required changes in output luminance, or the changes in required luminance between example embodiments and conventional approaches, are only examples. The exact percentages, including any efficiency gains or similar, will vary depending on the exact nature of the display apparatus, the required resolution changes, and so on. In any regard, it may still, nevertheless, be useful to ensure that the at least part of compensation described above ensures that the contrast ratio between the display content luminance and a background luminance is at or above 1.2 (i.e. 1.2:1). This might be achieved by reducing the resolution of the display content/increasing its size in isolation, or perhaps in combination with an increase in luminance of the display source (which includes one or more light sources thereof).

[0062] The display content described herein could be any suitable content. For example, the content could be part of an image, or could be a symbol, such as an icon, character, text, number, shape, line, dot and so on. It might be beneficial if the content is isolated, in that the content (e.g. when displayed) is not in functional or aesthetic contact with other content that does not need to have its resolution decreased/its size increased. The isolation provides space in which to in some way expand the displayed content.

[0063] The display apparatus may be pixelated in nature, meaning that the display source and/or the display screen is pixelated. With such pixelation, resolution and thus luminance decrease for output display content is more prevalent due to the modulation transfer function (MTF) or the contrast transfer function (CTF), described previously. In other examples, the display apparatus may not be pixelated. For instance, the problems described above can arise for reasons other than CTF or MTF, for example due to optical deformities in an optical system, such as aberrations or unwanted lens affects.

[0064] In some instances, the source and screen may be in close proximity, or may even form or be same apparatus or unit. For example, the source may serve as the screen. In another example, there may be an optical system between a source and the screen. The screen may form a part of the system.

[0065] The example embodiments have shown how output resolution and luminance may decrease toward an edge of a display screen. This has been found to be typical in head up displays. However, such decrease may occur in other locations. If the decrease is toward the

edge (i.e. periphery) of the screen, then the described compensation might involve a further beneficial affect. Decreasing the resolution/increasing the size of content at the periphery of the screen allows the content to be more visible in the peripheral vision of the user when the user is viewing centrally located content, since peripheral vision is not as well adapted at viewing or processing higher resolution content.

[0066] The example embodiments have been described with reference to a head up display. It will be appreciated that a head up display incorporates such displays as helmet or head mounted displays. Also, it will be appreciated that the general principles described above are also applicable to display apparatus in general, and are not necessarily limited to application to head up displays.

[0067] It will be appreciated that the problems described herein, and the inventive concept, can be defined in many different ways, using reference to such phrases as increasing or decreasing content resolution (e.g. size, and so on), increasing or decreasing contrast ratio, increasing or decreasing luminance. This is because at least these features are, of course, interrelated. Therefore, any single definition of the invention may, in some instance, use such terms in place of one another and/or interchangeably.

[0068] Although a few preferred embodiments have been shown and described, it will be appreciated by those skilled in the art that various changes and modifications might be made without departing from the scope of the invention, as defined in the appended claims.

[0069] Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0070] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0071] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0072] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A compensation method for a display apparatus, the display apparatus being capable of processing input content having an input resolution to display the content with a display resolution at a display screen, the processing being such that, without compensation, for a region of the display screen the content display resolution is lower than the content input resolution, resulting in a reduction in a contrast ratio for display content in that region, the method comprising:
 - at least partially compensating for the reduction in contrast ratio in advance, by decreasing the input resolution of the input content for display at the region.
2. The compensation method of claim 1, wherein the processing comprises optical processing, and/or signal processing.
3. The compensation method of any preceding claim, wherein the at least partial compensation comprises adjusting an input signal used in the generation and/or display of the content.
4. The compensation method of any preceding claim, wherein display content is subjected to an anti-aliasing function prior to display at the display screen, and wherein the anti-aliasing function is used to decrease the resolution of the content.
5. The compensation method of any preceding claim, wherein the decrease in contrast comprises a decrease in luminance of the display content, and/or wherein the decrease in input resolution of the input content results in an increase in luminance of the display content.
6. The compensation method of any preceding claim, wherein the content display resolution at the region is lower than content display resolution at another, different region of the display screen.
7. The compensation method of any preceding claim, wherein the at least partial compensation comprises ensuring that a contrast ratio between a display content luminance and a background luminance is at or above 1.2:1.
8. The compensation method of any preceding claim, wherein the display screen is at least partially transparent, and the background luminance is a luminance visible to a user through the at least partially transparent display screen.
9. The compensation method of any preceding claim,

wherein the at least partial compensation additionally comprises increasing an output luminance of a display source.

10. The compensation method of any preceding claim, wherein the at least partial compensation comprises increasing an output luminance of a display source, such that the decrease in the input resolution of the input content for display at the region, together with the increase in luminance of the display source, ensures that a contrast ratio between a display content luminance and a background luminance is at or above 1.2:1.

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11. The compensation method of any preceding claim, wherein the at least partial compensation comprises one or more of increasing a dimension, increasing a size, increasing a line width, or increasing a scale of the display content.

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12. The compensation method of any preceding claim, wherein the method comprises determining whether, and/or to what extent, the content display resolution is lower than the content input resolution for the region of the display, by one or more of modelling and measurement, in advance of implementing the at least partial compensation.

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13. A display apparatus capable of processing input content having an input resolution to display the content with a display resolution at a display screen, the processing being such that, without compensation, for a region of the display screen the content display resolution is lower than the content input resolution, resulting in a reduction in a contrast ratio for display content in that region, the display apparatus comprising or being in connection with a controller arranged to at least partially compensate for the reduction in contrast ratio in advance, by decreasing the input resolution of the input content.

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14. The display apparatus or method of any preceding claim, wherein the display screen is at least partially transparent and/or comprises a combiner.

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15. The display apparatus of any preceding claim, wherein the display apparatus is, or forms a part of, a head up display.

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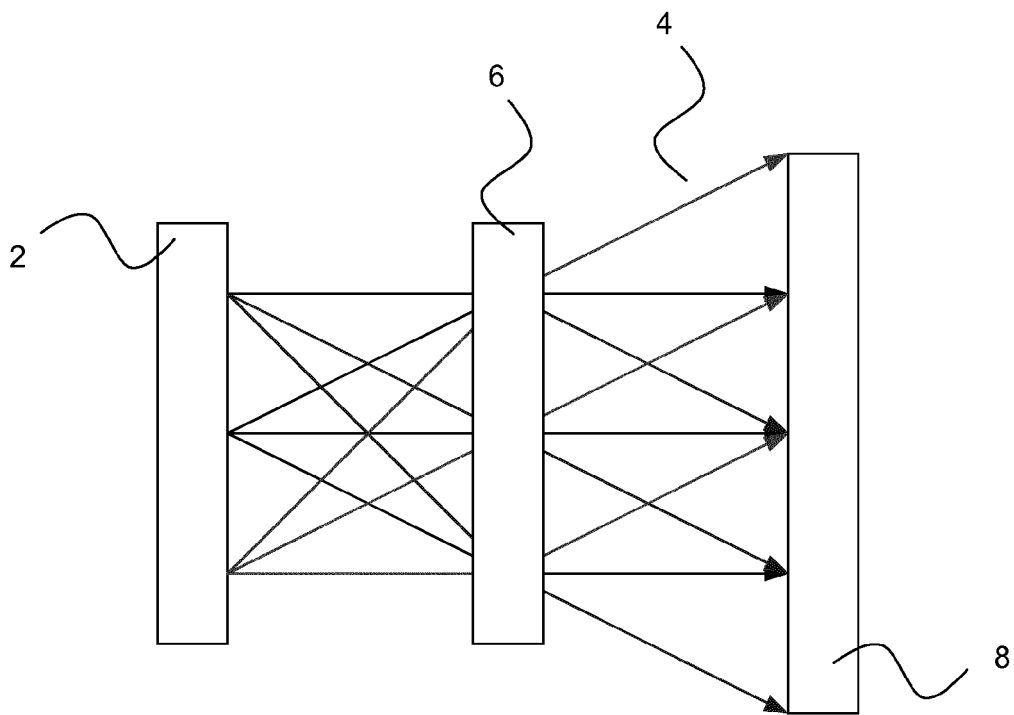


FIG. 1

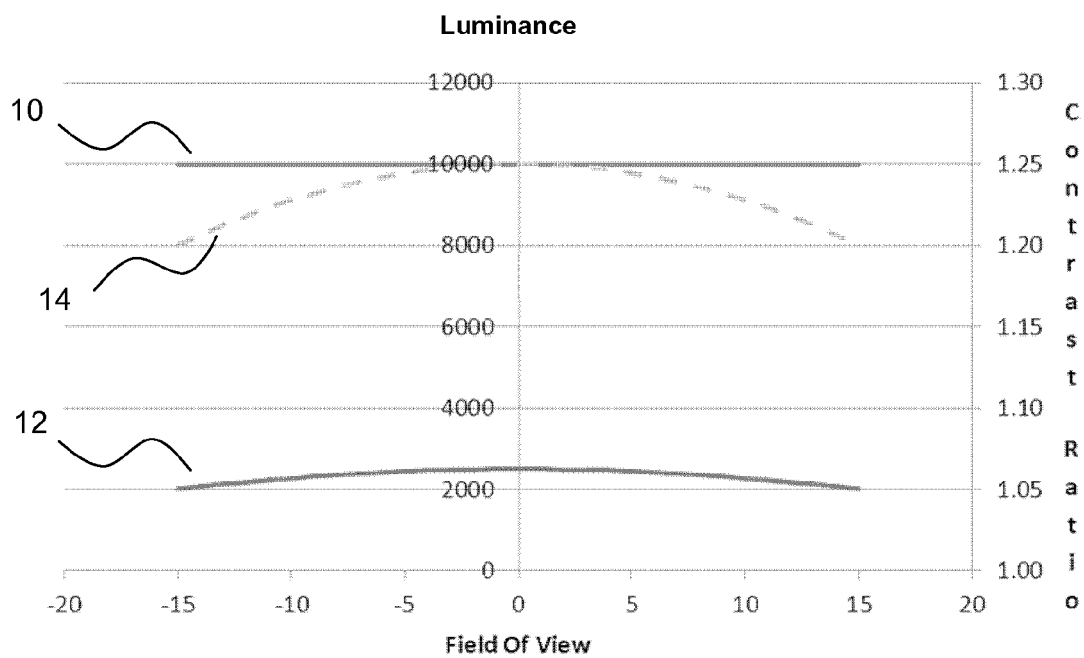


FIG. 2

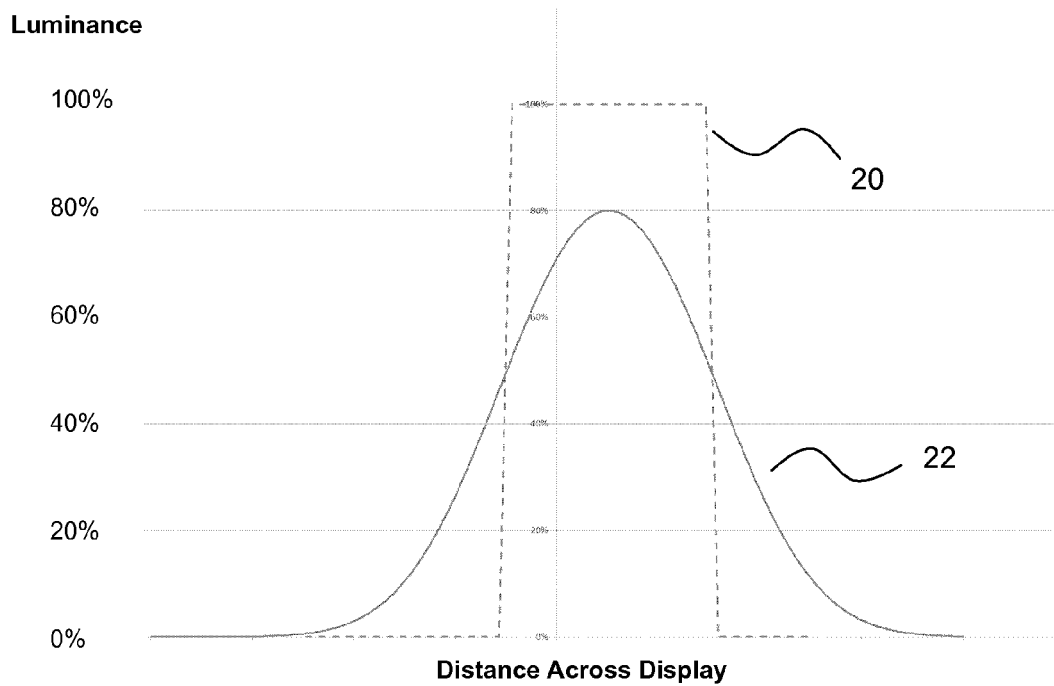


FIG. 3

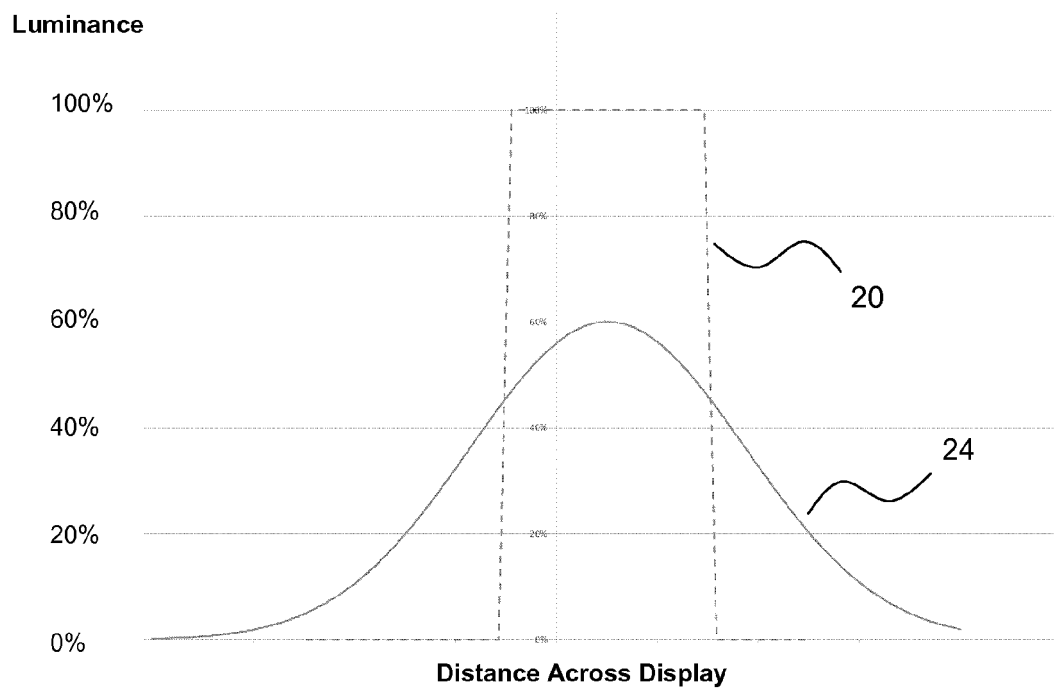


FIG. 4

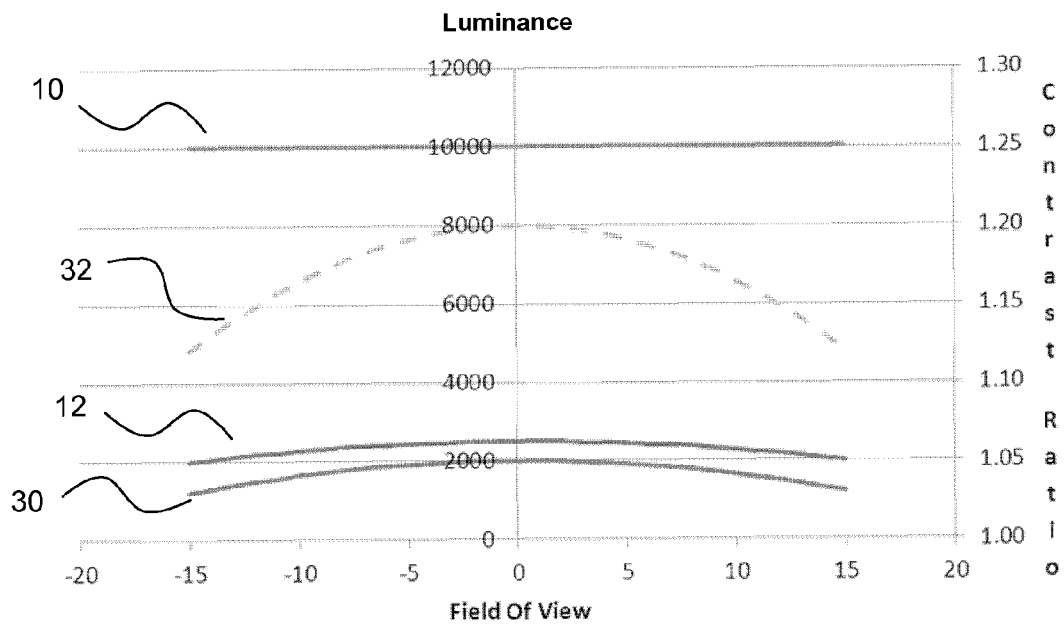


FIG. 5

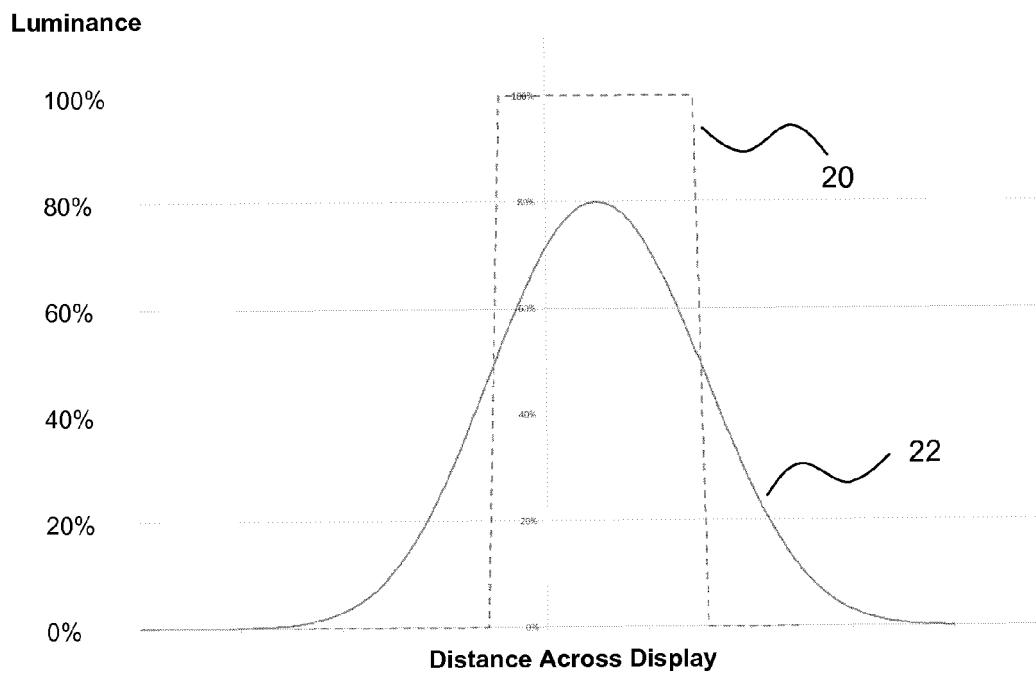
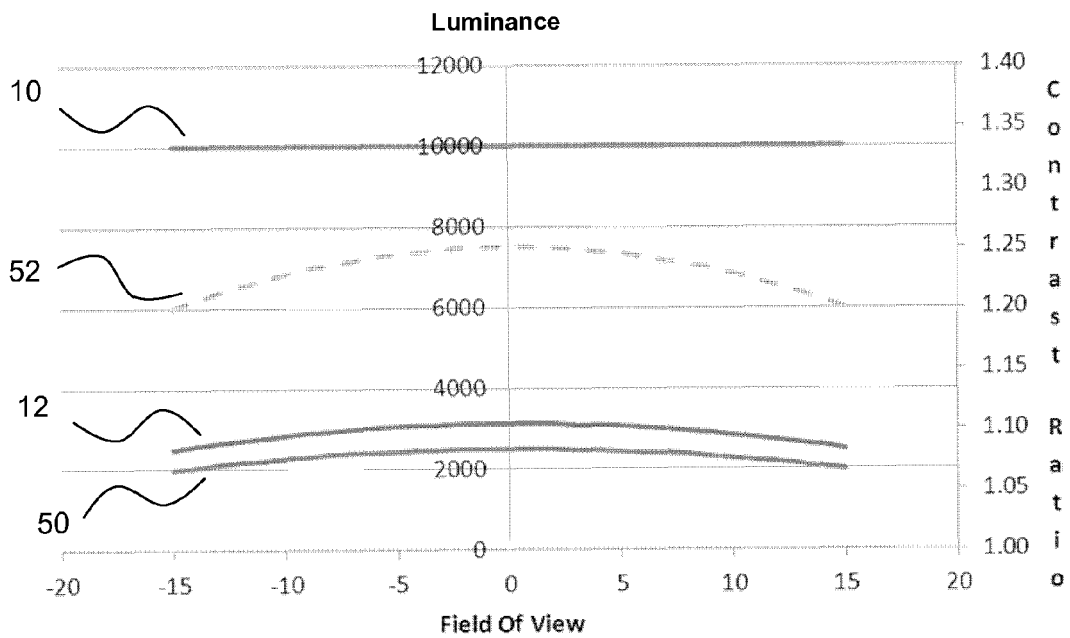
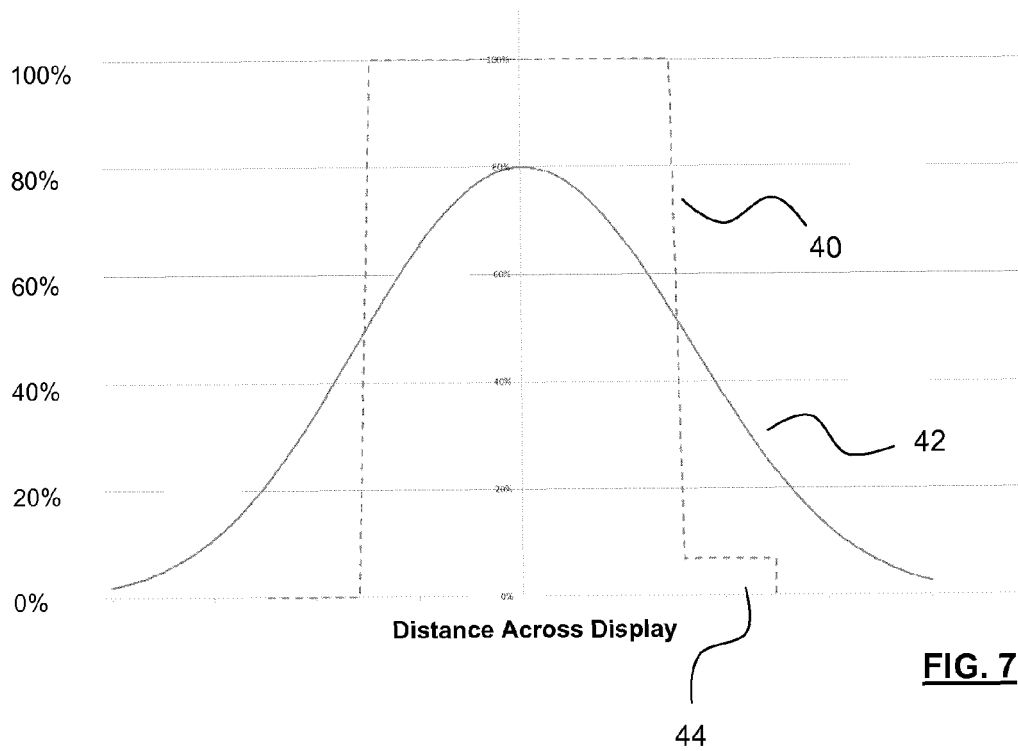


FIG. 6





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