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(54) **DISPLAY DEVICE AND METHOD FOR OPERATING A DISPLAY DEVICE**

(57) The present invention provides a display device (100, 200, 300, 400) for displaying images, the display device (100, 200, 300, 400) comprising a plurality of light emitting units (101, 403) configured to controllably emit visible light, a plurality of microscale light intensity sensors (102, 204, 404) configured to locally sense the intensity (103) of incoming light (405) at the light emitting units (101, 403), and a control unit (104) coupled to the

light emitting units (101, 403) and to the microscale light intensity sensors (102, 204, 404) and configured to control the emission intensity (105) of single ones of the light emitting units (101, 403) according to the locally sensed intensity (103). Further, the present invention provides a method for operating a display device (100, 200, 300, 400).

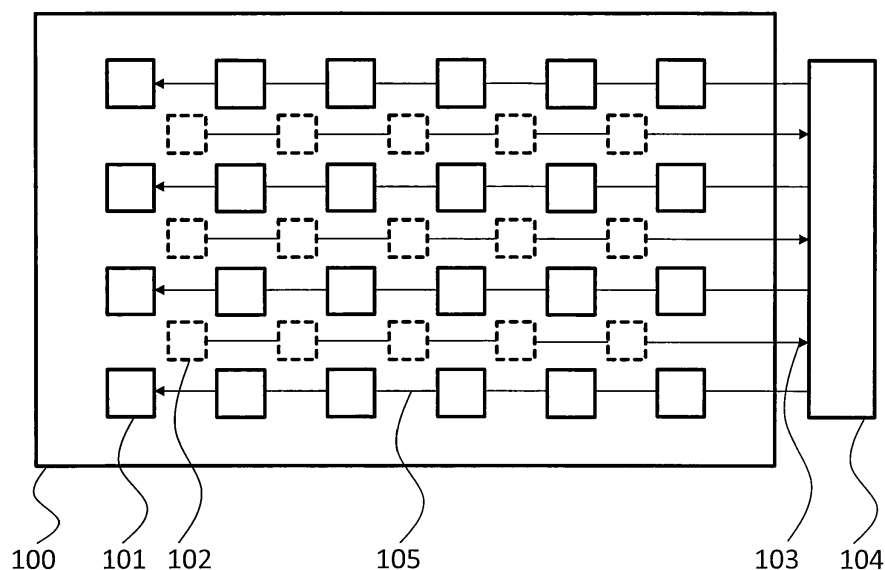


Fig. 1

Description**TECHNICAL FIELD**

5 [0001] The invention relates to a display device and a method for operating a display device.

BACKGROUND

10 [0002] Although applicable to any system with a display, the present invention will mainly be described in conjunction with displays of consumer electronic devices, like e.g. TV sets or mobile phones.

[0003] A plurality of modern electronic devices, like e.g. TV sets or smartphones, comprise displays to display content to users. The displays of such devices may e.g. be LCD displays, OLED displays or the like. Such displays emit colored light at the positions of the single pixels to recreate an image.

15 [0004] However, the perception of the image by a human eye may be influenced by the surrounding light intensity. If the intensity of incident light on the display is high, the content displayed on the display may e.g. not be perceived as good as with low intensity incident light.

[0005] Document US 2012 / 0 218 282 A1 discloses a method where the intensity or brightness of a display is adapted according to the intensity of the ambient light surrounding the display. With a light sensor the intensity of the ambient light is measured and the brightness of the whole display is adapted accordingly. This method offers little flexibility.

20 [0006] Accordingly, there is a need for an improved brightness control for displays.

SUMMARY OF THE INVENTION

25 [0007] The present invention provides a display device with the features of claim 1 and a method for operating a display device with the features of claim 8.

[0008] Therefore it is provided:

30 - A display device for displaying images, the display device comprising a plurality of light emitting units configured to controllably emit visible light, a plurality of microscale light intensity sensors configured to locally sense the intensity of incoming light, incoming referring to light incident onto the surface of the display device, e.g. from the sun or any artificial light, at the light emitting units, and a control unit coupled to the light emitting units and to the microscale light intensity sensors and configured to control the emission intensity or brightness of single ones of the light emitting units according to the locally sensed intensity.

35 [0009] It is further provided:

40 - A method for operating a display device with a plurality of light emitting units, and a plurality of microscale light intensity sensors, the method comprising emitting visible light with the light emitting units, locally sensing the intensity of incoming light at the light emitting units with the microscale light intensity sensors, and controlling the emission intensity of single ones of the light emitting units according to the locally sensed intensity.

[0010] The present invention is based on the finding that sensing the overall ambient light intensity or brightness may not provide enough information to adjust the brightness or emission intensity of the single light emitting units according to the lighting situation around the display device.

45 [0011] For example, direct sunlight can reflect upon the screen partly while another area of the screen is shadowed. If in this case the prior art light sensor is covered in the shadow, according to the prior art the screen brightness would be homogeneously low. The user may therefore hardly perceive the contents of the display at the area that is shone on by the sunlight.

50 [0012] With the microscale light intensity sensors the present invention provides the ability to locally detect or measure the brightness or intensity of the incident or ambient light at the positions of the single light emitting units. The detected intensity of the incident light may then be used to locally adapt the brightness or intensity of the light emitting units.

[0013] Therefore, with the present invention it is e.g. possible to dim an area of the display device that is covered by a shadow and increase the intensity of a display device in an area that is exposed e.g. to direct sunlight or artificial light.

55 [0014] This local intensity control of the present invention will provide a more homogenous appearance to the image displayed by the display device in otherwise difficult lighting conditions.

[0015] The light emitting units according to the present invention may refer to any type of pixel or subpixel arrangement, like e.g. used in LCD, OLED or AMOLED display devices. The light emitting units may e.g. all comprise a common backlight or at least area-wise comprise a common backlight. The content of the display may then be reproduced by

light modulating units, like e.g. in LCD displays. As an alternative self-illuminating pixels, like e.g. in OLED or AMOLED based displays may be used.

[0016] Further embodiments of the present invention are subject of the further subclaims and of the following description, referring to the drawings.

[0017] In an embodiment, the microscale light intensity sensors may be arranged between the light emitting units

[0018] If the microscale light intensity sensors are arranged between the light emitting units, the intensity of the ambient or incident light may be sensed locally at the light emitting units with high accuracy.

[0019] In this context "between the single light emitting units" refers to the area surrounding the single light emitting units. If e.g. a microscale light intensity sensor is placed between two or four of the single light emitting units, this microscale light intensity sensor will be capable of sensing the intensity of the incident light for these two or four single light emitting units.

[0020] An AMOLED display may e.g. be provided with so called diamond pixels. These pixels are square shaped pixels with the corners pointing upwards/downwards and sideways. Further, due to the wavelength dependent sensitivity of the human eye and the physical properties of the AMOLED pixels, the size of the single pixels will vary depending on their color. Therefore, there will be at least some free space between the single pixels of such an AMOLED display. That free space may be beneficially used according to the present invention to arrange the microscale light intensity sensors.

[0021] In an embodiment, the microscale light intensity sensors may be arranged on top of the light emitting units.

[0022] If a microscale light intensity sensor is e.g. placed on top of every one of the single light emitting units every microscale light intensity sensor will sense the intensity of incident light only for the respective one of the single light emitting units.

[0023] The microscale light intensity sensors may e.g. be arranged in a separate planar layer of photodetectors. It is understood, that in this case transparent photodetectors should be used, such a layer may be put in front of the screen (i.e. the TFT, OLED or AMOLED layers) of the display device and e.g. be connected to the control matrix (e.g. a TFT matrix) of the screen. The control matrix or any other control unit of the display device may then provide electric power to the sensors and evaluate the sensed values or data or forward the sensed values or data to the control unit.

[0024] The local intensity may then be adapted specifically for every single one of the light emitting units by the control unit based on the intensity measurements.

[0025] In an embodiment, the microscale light intensity sensors may be arranged below a light modulation layer of the light emitting units.

[0026] The microscale light intensity sensors may e.g. be arranged on the backlight layer of a display device. The backlight layer may e.g. comprise a full array LED arrangement, where the backlight generating LEDs are distributed over the surface of the backlight layer. Such an arrangement allows locally controlling the backlight intensity.

[0027] LCD displays will usually comprise the backlight layer and on top of the backlight layer a light modulating layer e.g. of TFT elements. The light modulating layer will not only allow the light from the LEDs to pass through to the surface of the display. The light modulating layer will also allow incident light to reach the backlight layer through the light modulating layer.

[0028] Therefore, the microscale light intensity sensors may be provided on the backlight layer, e.g. with a shielding against the stray light of the LEDs of the backlight layer. This allows flexibly positioning the microscale light intensity sensors without obstructing any of the light emitting units.

[0029] The incident or ambient light may be altered, e.g. modulated by the light modulating layer. Therefore, the measurement of the microscale light intensity sensors will only reflect the modulated incident light. However, a control unit or the like may have information about the current state of the light modulating layer and take into account this momentary state to compensate the measurements of the microscale light intensity sensors. Since the light modulating layer may e.g. work as a kind of filter for the incident light, the control unit may perform a wavelength-based compensation of the measured intensity values. With this compensation the true intensity of the incident light may be detected and the intensity of the backlight or the amount of dimming or filtering by the light modulating layer may be adapted accordingly.

[0030] In an embodiment, the microscale light intensity sensors may comprise graphene-based microscale light intensity sensors.

[0031] Graphene is a material that has a plurality of advantageous properties when used as a basis for the microscale light intensity sensors.

[0032] Graphene-based sensors may be transparent. This allows an easier mechanical combination with LED units, especially when the sensor is placed on top of the single light emitting units, without diffracting or blurring the light coming from each pixel of the TV screen.

[0033] Graphene-based sensors may be produced with very small outer dimensions and can be adjusted in terms of size to be suitable to squeeze into the area between the single pixels or subpixels of a display. Further, specific pixel and sub-pixel arrangements may be developed to fit the microscale light intensity sensors between the pixels and/or sub-pixels.

[0034] Finally, graphene-based sensors are tunable. This means that their receiving wavelength spectrum may be tuned with a control voltage, therefore, even at different times of the day, the amount of sunlight or any ambient indoor light may be sensed perfectly.

[0035] It is however understood, that any other type of light intensity sensors may be used that have the required size or other physical properties. Sensors that are placed on the backlight layer may e.g. be larger than sensors placed between single pixels or sub-pixels of the display and need not be transparent.

[0036] In an embodiment, the display device may comprise a power management unit coupled to the microscale light intensity sensors and configured to receive electrical energy from the microscale light intensity sensors.

[0037] Graphene-based microscale light intensity sensors not only serve as intensity sensors but also generate an electrical current that may be used to support the electrical power supply of the display device. The power management unit may e.g. combine electrical power from a mains supply with the electrical power harvested by the Graphene-based microscale light intensity sensors and provide the electric and electrical units of the display device with the respective electrical supply power.

[0038] In another embodiment, the control unit may comprise a look-up table or a mapping function for mapping the intensity sensed by the microscale light intensity sensors to respective brightness values for the single light emitting units.

[0039] Usually the mapping of the intensity sensed by the microscale light intensity sensors to respective brightness values will be static and a look-up table may e.g. be determined at development or in a calibration step during production of the display device and be permanently stored in the display device. However, there may be situations that may require or be advantageously handled by a mapping function. If for example, the microscale light intensity sensors are placed behind the light modulating layer together with the backlight LEDs, the mapping function may take into account the state of the light modulating layer that may e.g. change the color and intensity of the light falling onto the microscale light intensity sensors.

[0040] The control unit may e.g. control the single light emitting units to emit light of a specific color with a specific intensity. This may e.g. be useful for OLED or AMOLED display devices, where the single pixels or sub-pixels actively emit visible light.

[0041] For LCD displays or the like, the control unit may control the intensity of the backlight and the amount of dimming of the backlight by the TFT layer. With a full array or matrix LED backlight, the control unit may e.g. locally dim the LEDs of the backlight. If the LEDs or any other light source is not locally dimmable, the control unit may set the backlight brightness to the maximum needed value and then dim the single cells of the TFT layer accordingly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0042] For a more complete understanding of the present invention and advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings. The invention is explained in more detail below using exemplary embodiments which are specified in the schematic figures of the drawings, in which:

Fig. 1 shows a block diagram of an embodiment of a display device according to the present invention;

Fig. 2 shows a block diagram of another embodiment of a display device according to the present invention;

Fig. 3 shows a block diagram of another embodiment of a display device according to the present invention;

Fig. 4 shows a block diagram of another embodiment of a display device according to the present invention; and

Fig. 5 shows a flow diagram of an embodiment of a method according to the present invention.

[0043] In the figures like reference signs denote like elements unless stated otherwise.

DETAILED DESCRIPTION OF THE DRAWINGS

[0044] Fig. 1 shows a block diagram of a display device 100. The display device 100 comprises a plurality of light emitting units 101 and a plurality of microscale light intensity sensors 102 (shown with dashed lines). For sake of clarity, only one of the light emitting units 101 and one of the microscale light intensity sensors 102 are provided with reference signs.

[0045] The light emitting units 101 are arranged in a matrix arrangement with the light emitting units 101 being arranged in equidistant rows and columns. The microscale light intensity sensors 102 are also arranged in such a matrix arrangement and are interleaved with the light emitting units 101, such that a microscale light intensity sensor 102 lies on the crosslines connecting the four surrounding light emitting units 101. It is understood, that this arrangement is just an

exemplary arrangement and that any other arrangement is also possible.

[0046] The display device 100 further comprises a control unit 104 coupled to the light emitting units 101 and the microscale light intensity sensors 102.

[0047] The microscale light intensity sensors 102 locally sense the intensity 103 of incoming light and provide the intensity 103 to the control unit 104. The control unit 104 sets the emission intensity 105 for the light emitting units 101 according to the locally sensed intensity 103. This allows the control unit 104 to set the emission intensity 105 in patterns that may e.g. represent the pattern formed by incident light on the surface of the display device 100. If for example a shadow covers an area of the display device 100, while another area lies in direct sunlight, the measured intensity 103 will reflect this pattern and the control unit 104 may adjust the emission intensity 105 accordingly. The control unit 104 may e.g. comprise a look-up table or a mapping function for mapping the intensity 103 sensed by the microscale light intensity sensors 102 to respective brightness values for the single light emitting units 101.

[0048] The display device 100 may be any type of display, like e.g. a LCD TFT display, an OLED or AMOLED display or the like. The display may e.g. also be a large screen with single discrete LEDs. Further, the control unit 104 may be implemented in any controller that is present in the display device 100, e.g. as a firmware function, or alternatively as separate controller, programmable logic unit or the like.

[0049] The microscale light intensity sensors 102 in the display device 100 are arranged between the single light emitting units 101. This pattern may e.g. be provided with any type of microscale light intensity sensors 102 that are small enough to fit between the light emitting units 101. The light emitting units 101 may e.g. be pixels or sub-pixels of a LCD, OLED or AMOLED display or any other type of display. Because of their reduced size, graphene-based light intensity sensors 102 may be placed between the single light emitting units 101.

[0050] Especially with graphene-based light intensity sensors 102 other arrangements are also possible. Since graphene is transparent, a layer of graphene-based light intensity sensors 102 may be placed on top of the other layers of the display device 100. This is exemplified in Fig. 3.

[0051] Fig. 2 shows a detail of another display device 200. The display device 200 comprises a diamond pixel arrangement, as it may be used e.g. in AMOLED displays.

[0052] In Fig. 2 three rows of pixels 201, 202, 203 each with three pixels 201, 202, 203 are shown as the diamond pixel arrangement. It is understood, that only a section of the display device 200 is shown and that the display device 200 will comprise a larger pixel area.

[0053] The rows are shifted by half the horizontal distance of the pixels 201, 202, 203. The pixels 201, 202, 203 of the first and the third row are therefore vertically aligned to each other. The first and the third row further comprise only green pixels 201. The second row in contrast comprises blue pixels 202 alternating with red pixels 203. In an AMOLED display the green pixels 201 may e.g. be smaller than the blue pixels 202 and the red pixels 203.

[0054] The display device 200 further comprises graphene-based light intensity sensors 204. The graphene-based light intensity sensors 204 are arranged in the spacing between the pixels 201, 202, 203. The graphene-based light intensity sensors 204 may e.g. be combined with graphene-based display arrangements and be produced together with other graphene-based elements during the production process of the graphene-based display.

[0055] Fig. 3 shows a block diagram of another display device 300. The display device 300 in contrast to the display device 200 comprises a graphene-based photodetector layer 305 that comprises the light intensity sensors (not separately shown).

[0056] Fig. 3 shows a sectional or cut view of a LCD display with an anode layer 301, an organic layer 302 that creates the RGB colors, a cathode layer 303 and the TFT layer 304. The graphene-based photodetector layer 305 comprises graphene-based photodetectors. As already indicated above, graphene is transparent and therefore, the graphene-based photodetector layer 305 does not obstruct the view for the users.

[0057] The graphene-based photodetector layer 305 may e.g. be connected to the TFT layer 304 via data lines 307 and power lines 306. The control unit that controls the TFT layer 304 is not separately shown. However, the display device 300 comprises a power management unit 308. The power management unit 308 may receive electrical power from the graphene-based photodetector layer 305 and may use this electrical power to directly power electric consumers in the display device 300. In addition to the electrical power from the graphene-based photodetector layer 305 the power management unit 308 may also use electrical power provided by a power supply in the display device 300.

[0058] Fig. 4 shows a block diagram of another display device 400. In the display device 400 a light modulation layer 401 covers the backlight layer 402. The light modulation layer 401 and the backlight layer 402 may be layers as in normal LCD displays. However, the backlight layer 402 in addition to LEDs 403 also comprises light intensity sensors 404.

[0059] Incident or incoming light 405 may be partially reflected on the surface of the light modulation layer 401. However, at least part of the incoming light 405 will travel through the light modulation layer 401 and hit the light intensity sensors 404. As an option the leftmost light intensity sensor 404 is protected by covers 407 from the stray light of the LEDs 403.

[0060] As already indicated above, a control unit (not separately shown) of the display device 400 may receive the sensed intensity from the light intensity sensors 404. The control unit may further compensate for the reflection and any other modification that the light modulation layer 401 may provide to the incoming light 405.

[0061] With this embodiment local dimming according to the incident light may be provided e.g. to TFT LCD screens with standard light intensity sensors 404.

[0062] It is understood, that the single features of the shown embodiments may be freely combined. The power management unit 308 may for example also be used with the display device 100, the display device 200 and the display device 400, and would be especially useful in mobile devices to reduce power consumption.

[0063] For sake of clarity in the following description of the method based Fig. 5 the reference signs used above in the description of apparatus based Figs. 1 - 4 will be maintained.

[0064] Fig. 5 shows a flow diagram of an embodiment of a method for operating a display device 100, 200, 300, 400 with a plurality of light emitting units 101, 403, and a plurality of microscale light intensity sensors 102, 204, 404.

[0065] The method comprises emitting S1 visible light with the light emitting units 101, 403. The method further comprises locally sensing S2 the intensity 103 of incoming light 405 at the light emitting units 101, 403 with the microscale light intensity sensors 102, 204, 404, and controlling S3 the emission intensity 105 of single ones of the light emitting units 101, 403 according to the locally sensed intensity 103.

[0066] Controlling S3 the emission intensity 105 may comprise mapping the sensed intensity 103 to respective brightness values for the single light emitting units 101, 403 based on a look-up table or a mapping function.

[0067] The intensity 103 of incoming light 405 may e.g. be sensed between the light emitting units 101, 403, on top of the light emitting units 101, 403, or below a light modulation layer 401 of the light emitting units 101, 403.

[0068] The intensity 103 of incoming light 405 may e.g. be sensed with graphene-based microscale light intensity sensors 102, 204, 404. The method may further comprise harvesting electrical energy from the microscale light intensity sensors 102, 204, 404.

[0069] Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations exist. It should be appreciated that the exemplary embodiment or exemplary embodiments are only examples, and are not intended to limit the scope, applicability, or configuration in any way. Rather, the foregoing summary and detailed description will provide those skilled in the art with a convenient road map for implementing at least one exemplary embodiment, it being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope as set forth in the appended claims and their legal equivalents. Generally, this application is intended to cover any adaptations or variations of the specific embodiments discussed herein.

[0070] The present invention provides a display device 100, 200, 300, 400 for displaying images, the display device 100, 200, 300, 400 comprising a plurality of light emitting units 101, 403 configured to controllably emit visible light, a plurality of microscale light intensity sensors 102, 204, 404 configured to locally sense the intensity 103 of incoming light 405 at the light emitting units 101, 403, and a control unit 104 coupled to the light emitting units 101, 403 and to the microscale light intensity sensors 102, 204, 404 and configured to control the emission intensity 105 of single ones of the light emitting units 101, 403 according to the locally sensed intensity 103. Further, the present invention provides a method for operating a display device 100, 200, 300, 400.

List of reference signs

[0071]

100, 200, 300, 400	display device
101	light emitting units
102	microscale light intensity sensors
103	intensity
104	control unit
105	emission intensity

201	green sub-pixels
202	blue sub-pixels
203	red sub-pixels
204	microscale light intensity sensors

301	anode layer
302	organic layer
303	cathode layer
304	TFT layer
305	photodetector layer
306	power line

307 data line
308 power management unit

401 light modulation layer
402 backlight layer
403 LEDs
404 light intensity sensors
405 incoming light
406 reflected light

S1 - S3 method steps

Claims

1. Display device (100, 200, 300, 400) for displaying images, the display device (100, 200, 300, 400) comprising:
 - a plurality of light emitting units (101, 403) configured to controllably emit visible light,
 - a plurality of microscale light intensity sensors (102, 204, 404) configured to locally sense the intensity (103) of incoming light (405) at the light emitting units (101, 403), and
 - a control unit (104) coupled to the light emitting units (101, 403) and to the microscale light intensity sensors (102, 204, 404) and configured to control the emission intensity (105) of single ones of the light emitting units (101, 403) according to the locally sensed intensity (103).
2. Display device (100, 200, 300, 400) according to claim 1, wherein the microscale light intensity sensors (102, 204, 404) are arranged between the light emitting units (101, 403).
3. Display device (100, 200, 300, 400) according to claim 1, wherein the microscale light intensity sensors (102, 204, 404) are arranged on top of the light emitting units (101, 403).
4. Display device (100, 200, 300, 400) according to claim 1, wherein the microscale light intensity sensors (102, 204, 404) are arranged below a light modulation layer (401) of the light emitting units (101, 403).
5. Display device (100, 200, 300, 400) according to any one of the preceding claims, wherein the microscale light intensity sensors (102, 204, 404) comprise graphene-based microscale light intensity sensors (102, 204, 404).
6. Display device (100, 200, 300, 400) according to claim 5, comprising a power management unit (308) coupled to the microscale light intensity sensors (102, 204, 404) and configured to receive electrical energy from the microscale light intensity sensors (102, 204, 404).
7. Display device (100, 200, 300, 400) according to any one of the preceding claims, wherein the control unit (104) comprises a look-up table or a mapping function for mapping the intensity (103) sensed by the microscale light intensity sensors (102, 204, 404) to respective brightness values for the single light emitting units (101, 403).
8. Method for operating a display device (100, 200, 300, 400) with a plurality of light emitting units (101, 403), and a plurality of microscale light intensity sensors (102, 204, 404), the method comprising:
 - emitting (S1) visible light with the light emitting units (101, 403),
 - locally sensing (S2) the intensity (103) of incoming light (405) at the light emitting units (101, 403) with the microscale light intensity sensors (102, 204, 404), and
 - controlling (S3) the emission intensity (105) of single ones of the light emitting units (101, 403) according to the locally sensed intensity (103).
9. Method according to claim 8, wherein the intensity (103) of incoming light (405) is sensed between the light emitting units (101, 403).
10. Method according to claim 8, wherein the intensity (103) of incoming light (405) is sensed on top of the light emitting units (101, 403).

11. Method according to claim 8, wherein the intensity (103) of incoming light (405) is sensed below a light modulation layer (401) of the light emitting units (101, 403).
12. Method according to any one of the preceding claims 8 to 11, wherein the intensity (103) of incoming light (405) is sensed with graphene-based microscale light intensity sensors (102, 204, 404).
13. Method according to claim 12, comprising harvesting electrical energy from the microscale light intensity sensors (102, 204, 404).
14. Method according to any one of the preceding claims 8 to 13, wherein controlling the emission intensity (105) comprises mapping the sensed intensity (103) to respective brightness values for the single light emitting units (101, 403) based on a look-up table or a mapping function.

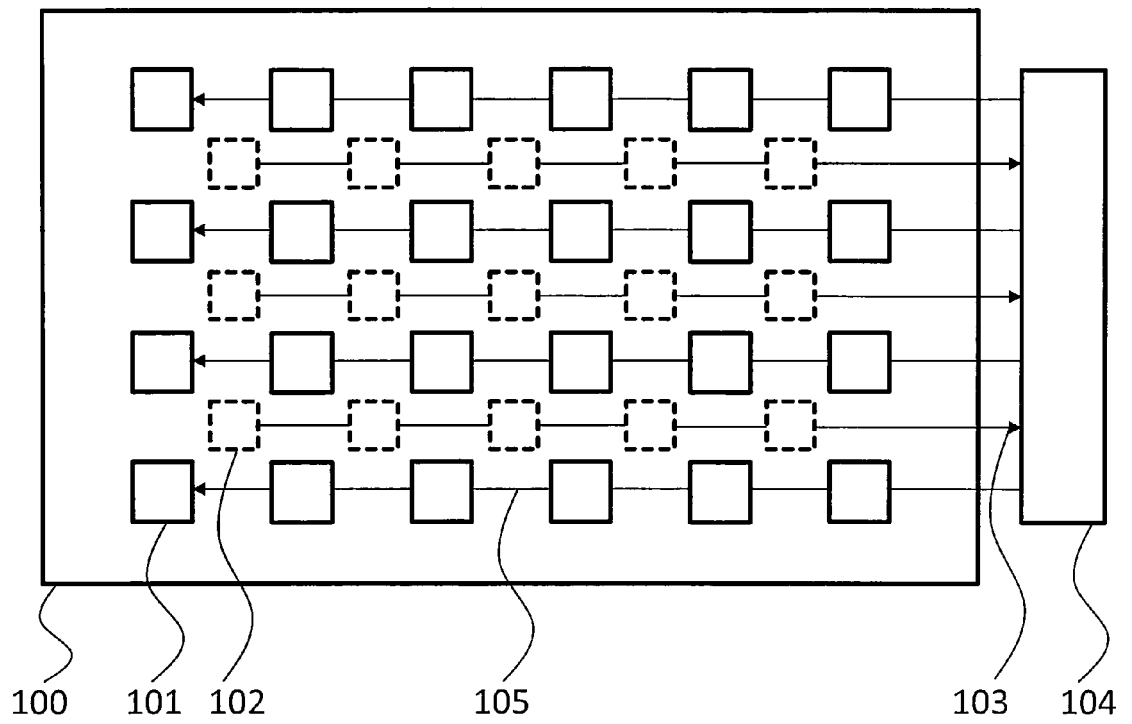


Fig. 1

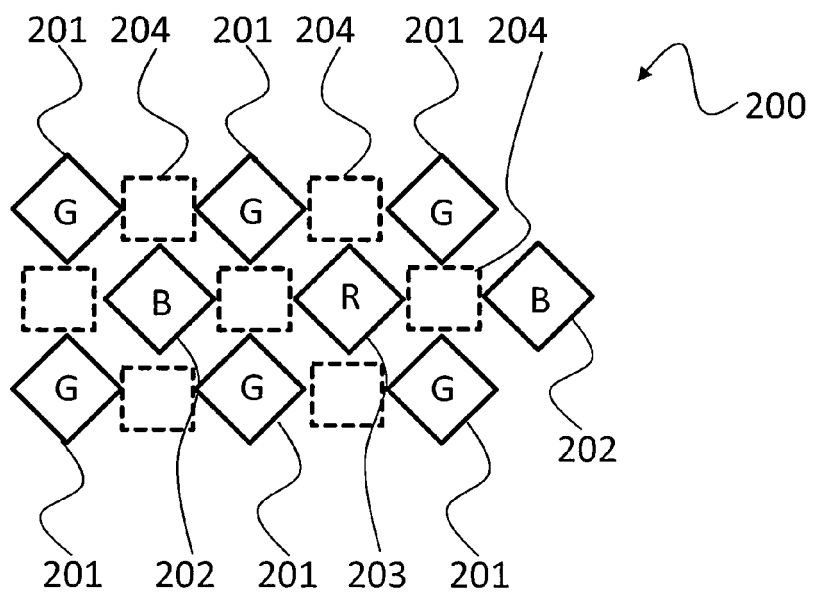


Fig. 2

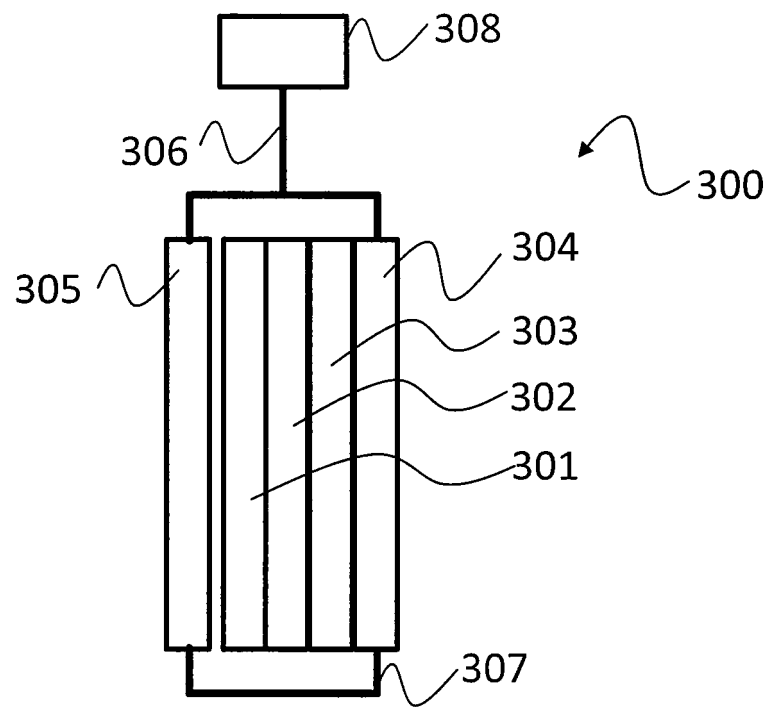


Fig. 3

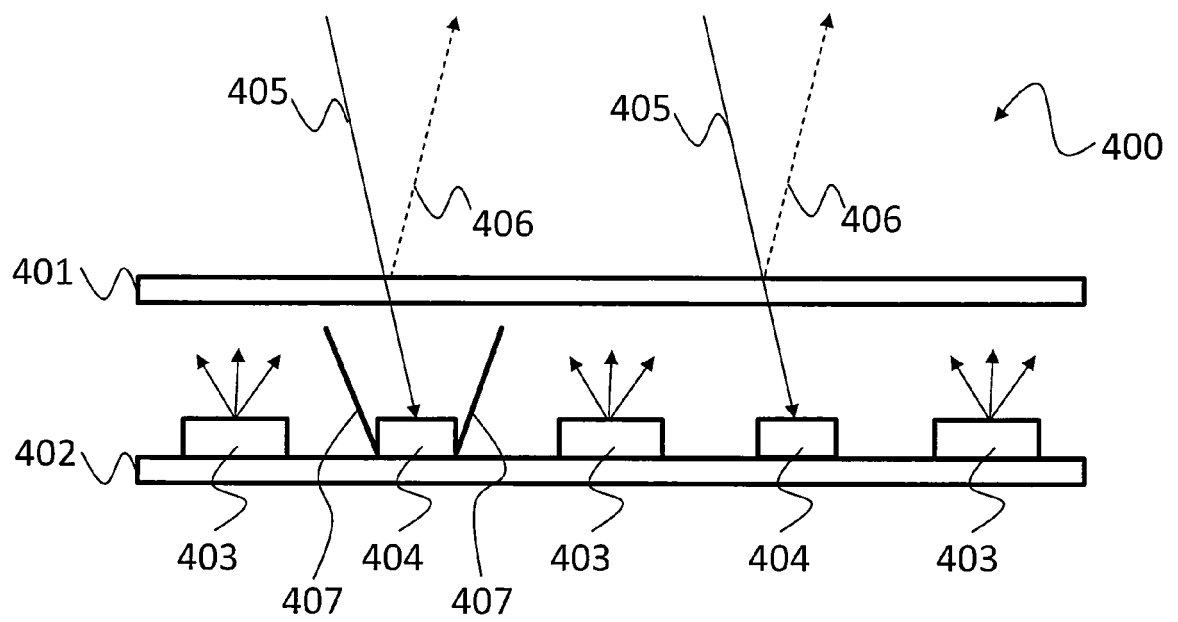


Fig. 4

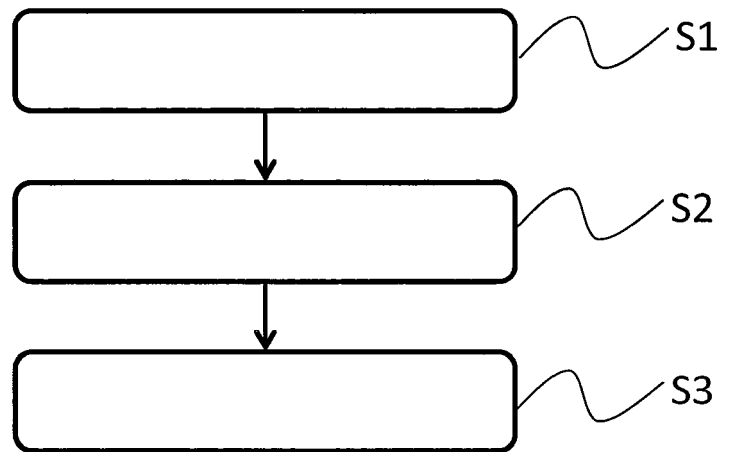


Fig. 5



EUROPEAN SEARCH REPORT

 Application Number
 EP 17 16 7105

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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 2016/320887 A1 (LI GUOSHENG [CN] ET AL) 3 November 2016 (2016-11-03)	1-3,8-10	INV. G09G3/3225 G09G3/34
Y	* paragraph [0016] - paragraph [0035]; figures 1-8 *	5,7,12,14	

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Y	* paragraph [0019] - paragraph [0061]; figures 1-8 *	5,7,12,14	

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Y	* paragraph [0030] - paragraph [0064]; figures 1-7 *	5-7,12-14	

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 May 2017	Examiner Harke, Michael
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			

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 EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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