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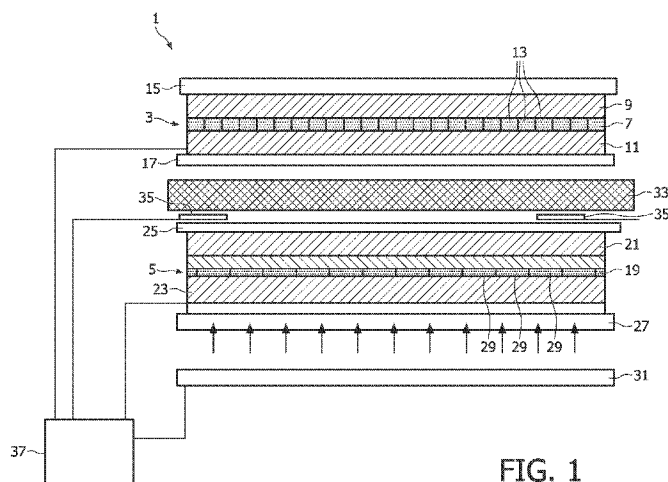


FIG. 1

(57) Abstract: A display (1) for displaying an image and a method for driving such display is proposed. Therein, the display comprises: a background light (31), a first LCD panel (3) defining an array of pixel elements (13), a second LCD panel (5) defining an array of pixel elements (29) and a control unit (37) for driving the first and second LCD panels (3, 5). The second LCD panel (5) is a color display and is arranged between the first LCD panel (3) and the background light (31). The control unit (37) is adapted to control the second LCD panel (5) such that a white color point of the display (1) may be adjusted. Preferably, a diffuser (33) is arranged between the first display (3) and the second display (5). Accordingly, on the one hand, such display shows enhanced displaying properties such as an increased contrast and viewing angle, while, on the other hand, the white color point of the display can be adjusted as desired by using the control unit (37) for correspondingly controlling the second LCD panel (5) being preferably a low resolution color display.

HIGH CONTRAST LIQUID CRYSTAL DISPLAY WITH ADJUSTABLE WHITE COLOR POINT

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FIELD OF THE INVENTION

The present invention relates to a display for displaying an image, particularly a display having a background light and a first and a second LCD panel stacked on top of each other. Furthermore, the present invention relates to a method for driving such display, a computer program product which is adapted to perform such method when executed on a computer and a computer-readable medium having such computer program product stored thereon.

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BACKGROUND OF THE INVENTION

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Presently, LCD monitors are conquering the market: TV, desktops, laptops, touch screens, medical displays, avionic and automotive products. A liquid crystal display (LCD) generally comprises a plurality of picture elements (pixels) arranged in rows and columns. The operation of a liquid crystal display is based on light modulation in a liquid crystal cell including an active layer of a liquid crystal material. By applying an electric field over the liquid crystal layer, the polarization of the light passing through this layer may be modified. In LCD monitors, this effect is used to control the light emission from individual pixel elements. To this end, the liquid crystal layer is sandwiched in between two polarizers.

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LCDs have clear advantages as compared with CRT-based technologies in terms of weight, size, energy consumption, etc. However, shortcomings of conventional LCD monitors are known as well such as low brightness, low dynamic contrast ratio, narrow viewing angle, backlight colour deviation, image motion blurring, etc. These shortcomings may prevent the use of LCD monitors in some professional applications where a maximum performance is required. Typical examples would be:

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control of flights, medical image diagnostics and image-guided surgery. In home TVs, the improvement of LCDs may also be desired, mainly in black level.

Although LCD displays are already being used in hospitals for many applications, it is recognized that especially for demanding applications like X-ray imaging, the current LCD image quality may be inferior to conventional X-ray films. In the medical imaging domain, it may be necessary that the image quality must satisfy the standard DICOM (Digital Imaging and Communication in Medicine). The realization of this standard in imaging modalities is strongly case-dependent: cardio-vascular imaging (CV) needs are different from X-ray chest diagnostics; X-ray chest diagnostics may be different from mammography, etc.

Conventional LCD monitors may suffer from the following problems or restrictions:

(1) Typical conventional colour LCD monitors may have a dynamic contrast ratio of 400:1, which is lower than that of 700:1 for conventional cathode ray tubes (CRT). The reason for that may be light leakage through the liquid crystal panel and ambient light reflected from the surface. In medical applications, a contrast of at least 800:1, in some cases 10.000:1, may be desired.

(2) At large viewing angles, the contrast of conventional LCD monitors may be poor. Whereas the contrast ratio may be e.g. 400:1 at a viewing angle of 0°, i.e. perpendicular to the screen, the contrast ratio may drop below 100:1 at viewing angles of more than 70°. In medical applications, a plurality of physicians may have to look on a screen simultaneously, e.g. while doing image-guided surgery, so that it may be desired that at an angle of about 70°, the contrast ratio should be more than 1000:1.

(3) The so-called “white point” or “white colour point” of LCD monitors may deviate from one device to another, even within the same model line. Therein, the white point, which is often also referred to as “reference white” or “target white” in technical documents, may be defined as a set of tristimulus values or chromaticity coordinates that serve to define the colour “white” in image capture, encoding or reproduction. Nowadays, monitor suppliers can specify a colour tolerance of 10 JNDs (just noticeable difference) or worse, while human eye can distinguish a change of 1 JND of colour. Colour differences may become very annoying when LCD monitors are e.g. used in a side-by-side arrangement. In the medical domain, 4 to 6 monitors are often

used side-by-side and physicians may have to analyze a whole set of images, which is displayed on the plurality of monitors, at once. In such applications, colour tuning of the images itself may be forbidden due to possible loss in dynamic range of the image information.

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SUMMARY OF THE INVENTION

There may be a need for a display for displaying an image, a method for driving such display, a computer program product adapted to perform such method when executed on a computer and a computer-readable medium having such computer
10 program product stored thereon wherein at least some of the above described shortcomings of prior systems are at least partly overcome. Particularly, there may be a need for a display having a high contrast ratio of for example more than 1000:1 wherein this contrast ratio can be obtained under a wide range of viewing angles of for example up to 70° and wherein the white colour point of the display can be selectively adjusted.
15 Furthermore, it may be advantageous to provide a display having improved properties at reasonable costs.

This need may be met by the subject-matter according to one of the independent claims. Advantageous embodiments of the present invention are described in the dependent claims.

20 According to a first aspect of the present invention, a display for displaying an image is provided wherein the display comprises a background light, a first LCD panel defining an array of pixel elements, a second LCD panel defining an array of pixel elements and a control unit for driving the first and second LCD panels. Therein, the second LCD panel is arranged between the first LCD panel and the background light
25 and is a colour LCD panel. The control unit is adapted to control the second LCD panel such that a white color point of the display may be adjusted.

A gist of the invention may be seen as being based on the following idea:

Two LCD panels are stacked on top of each other and in front of a background light such that light coming from the background light is first transmitted
30 through the second LCD panel and then through the first LCD panel before being emitted from the display in the direction to an observer. The rear side, second LCD

panel is a colour LCD panel while the front side, first LCD panel may be a black/white LCD panel.

Both LCD panels may have their own specific brightness range. For example, each of the LCD panels may have an 8 bit brightness scale (dynamic range).

- 5 Accordingly, the image content on the display comprising both panels may be boosted to a dynamical range corresponding to the multiplication of the two specific dynamic ranges of the respective LCD panels: (dynamic range (panel 1)) x (dynamic range (panel 2)). Accordingly, a dynamic contrast ratio of e.g. about 70.000:1 may be achieved which is above the actual limit of 10.000:1 which can be perceived by a human eye.

- 10 At the same time, the viewing angle up to which images can be observed with an acceptable contrast ratio may become as wide as 170°. This may happen due to the smart design of the LCD panel stack. Optical polarization properties of a single liquid crystal panel are such that it dumps the light of wrong polarization and/or direction. When panels are combined or stacked together, this effect may be squared.

- 15 Thereby, an increased viewing angle may be achieved.

- Furthermore, as the second LCD panel is a colour LCD panel, the white point of the display or of an image to be displayed can be tuned simply by adjusting the colour content/colour setting at the second LCD panel. Accordingly, a multiplicity of displays which are for example arranged adjacent to each other may be adjusted to have
- 20 the same white colour point such that a user can easily compare images displayed on the different displays without being distracted by different white colour points in the different images. Furthermore, as the second LCD panel includes an array with a plurality of pixel elements, the white colour point can even be adjusted locally within the two-dimensional area of the second LCD panel.

- 25 The control unit of the display is adapted to control the second LCD panel such that a white colour point of the display may be adjusted. For this purpose, the control unit may have an input port for inputting a desired value for the white colour point. For example, the desired white colour point can be input by indicating its coordinates XYZ in the CIE colour space or, alternatively, by indicating its tristimulus
- 30 values in the LMS colour space. Having indicated such desired white colour point, the control unit can then determine specific settings to control the second LCD panel accordingly to obtain the desired white colour light after transmittance through the

second LCD panel. For such purpose, the control unit may derive corresponding setting values for example from a previously generated lookup table. Alternatively, the control unit can derive the corresponding setting values using the feedback of sensors which are adapted and arranged to detect the colour and/or intensity of light transmitted through
5 the second LCD panel.

In the following, further possible features, details and advantages of embodiments of the present invention are mentioned.

The background light can be any light source which is adapted and arranged in order to emit light which then can be transmitted through the first and
10 second LCD panels. For example, the background light can be realized by using light-emitting diodes, LEDs. Light coming from such LEDs may be coupled into a light diffusing element which diffuses and redirects the light in order to homogeneously illuminate the first and second LCD panels from the rear side.

The first and second LCD panels each include an array of pixel elements
15 wherein in each pixel element a liquid crystal layer being arranged between the two electrodes can be controlled such as to either transmit light coming from the background light or to at least partially block such light. The entire first and second LCD panels each may have a plurality of pixel elements arranged in rows and columns in a two-dimensional plane. Each of the LCD panels may be of the twisted nematic (TN) type or
20 the supertwisted nematic (STN) type. The pixel elements of each of the LCD panels may have a uniform size throughout the entire array. Furthermore, pixel elements of the first LCD panel and pixel elements of the second LCD panel may have the same size or, preferably, may differ in size. The first LCD panel and the second LCD panel may be arranged parallel and, preferably, directly adjacent to each other and, preferably, also to
25 the background light.

While the first LCD panel may be a black/white LCD panel wherein each pixel element is adapted to generate one of a range of greyscale values, e.g. 256 greyscale values, the second LCD panel is a colour LCD panel. Such colour LCD panel is adapted to generate one of a multiplicity of colours wherein, furthermore, the colour
30 may be scaled concerning its brightness. For this purpose, each pixel element of the second, colour LCD panel may comprise a plurality of sub-pixels, e.g. three sub-pixels with respective red, green and blue colour filters, to create each colour pixel. Through

careful control and variation of a voltage applied to the respective sub-pixel, the intensity of each sub-pixel can be set within a predetermined range, for example within 256 shades. Combining the sub-pixels produces a possibility palette of for example 16.8 million colours (256 shades of red x 256 shades of green x 256 shades of blue).

- 5 Accordingly, light coming from the background light and having an original tone of white, i.e. an original white colour point, can be transmitted through the second LCD panel and, by suitably controlling the second LCD panel, the colour of this transmitted light can be suitably influenced.

- According to an embodiment of the present invention, the display further
- 10 includes sensor elements adapted to measure an intensity and/or a colour of light transmitted through the second LCD panel. For example, a plurality of sensor elements can be arranged on a side of the second LCD panel opposite to the side of the background light. Each sensor element may correspond to a specific partial area of the second LCD panel and measure the light transmitted through this partial area.
- 15 Accordingly, the intensity and/or colour of the transmitted light can be determined for each of the partial areas of the second LCD panel. Alternatively, only a single sensor element may be used for measuring the intensity and/or colour of light transmitted through the second LCD panel, assuming a homogeneous intensity and/or colour distribution throughout the surface of the second LCD panel. The measurement values
- 20 provided by the sensor element(s) can then be used to select or adapt the white colour point of the display.

Alternatively, the white colour point of the display may be calibrated using measurements acquired by one or more external sensor elements. Accordingly, the display may be pre-calibrated e.g. before actually using it for displaying images.

- 25 According to a further embodiment of the present invention, the control unit is adapted to control the second LCD panel such that a white colour point of the display is adjusted automatically based on data measured by sensor elements. In other words, the control unit can automatically determine setting values for the pixel elements of the second LCD panel based on the knowledge about the intensity and/or colour of
- 30 light transmitted through the second LCD panel as it is included in the data measured by one or more sensor elements. Automatically adjusting the white colour point of a display may significantly simplify the work of a user when using a multiplicity of displays as each

of the displays may be adjusted to the same white colour point such that images shown on the different displays can be easily compared.

According to a further embodiment of the present invention, the control unit is adapted to control the second LCD panel such that a white colour point of the display is adjusted locally with respect to positions within the two-dimensional array of pixel elements based on data measured by sensor elements at the respective positions. In other words, the white colour point is not adjusted uniformly over the entire surface of the display. Instead, it can be taken into account that the background light and/or the second LCD panel may be inhomogeneous concerning the light emitted therefrom or transmitted therethrough and that, accordingly, the light transmitted through the second LCD panel may have different white colour points at different positions within the area of the LCD panel. Accordingly, it may be advantageous to provide different setting values to the pixel elements of the second LCD panel at different positions.

According to a further embodiment of the present invention, the control unit is adapted to control the second LCD panel such that a selectable region of the display is highlighted by adjusting the colour of the background light transmitted through the second LCD display. For example, while the display is normally used in a black/white fashion thereby using the possibly higher resolution of the upper, first LCD panel, it may be advantageous to highlight a specific area of the display by giving this area a coloured background using the colour, second LCD panel. Even if the resolution of the second LCD panel is lower than the resolution of the first LCD panel, such highlighting may not reduce the overall resolution of the display being determined by the higher resolution of the first LCD display while at the same time drawing an observer's attention to the highlighted region.

According to a further embodiment of the present invention, the control unit is adapted to process image information of the image to be displayed such that a first portion of the image information is displayed on the first LCD panel and a second portion of the image information is displayed on the second LCD panel. Thus, the original image content may be distributed across the two LCD panels which, as a result, may yield a very high contrast, the contrast being the product of the contrast ratio of the individual panels, and, moreover, yield an increased bit depth of the grey scale values. For example, in medical applications, a bit depth of 10 or more bits may be

advantageous as for example original X-ray data as measured with, for instance, mammography X-ray detectors, already contain 14 to 16 bit information. Accordingly, with the present embodiment, it would be possible to display nearly all of these different grey levels.

5 According to a further embodiment of the present invention, the control unit as described with respect to the previous embodiment is adapted to display the first portion of the image with a higher resolution than the second portion. In other words, details of the original image can be displayed on the first LCD panel with a high resolution, preferably a highest possible resolution corresponding to the resolution as
10 defined by the size of the LCD pixel elements, whereas rougher structures of the original image may be displayed on the second LCD panel with a reduced resolution corresponding to a larger pixel size or to a resolution area which includes a plurality of pixel elements. Thereby, a high resolution of the entire display can be maintained while reducing the computational effort performed in the control unit and/or the costs for the
15 control unit.

 According to a further embodiment of the present invention, the second LCD panel has a lower resolution than the first LCD panel. In other words, the size of the pixel elements of the second LCD panel is larger than the size of the pixel elements of the first LCD panel. Similar advantages as with the previous embodiment may be
20 obtained while furthermore reducing the costs of the display due to the low resolution second LCD panel.

 Furthermore, it may be advantageous to adapt and arrange the first and second LCD panels in a way such that borders separating neighbouring pixel elements in the second LCD panel do overlap as few as possible with corresponding borders
25 separating pixel elements within the first LCD panel. Thereby, parallax effects may be reduced.

 According to a further embodiment of the present invention, the display further comprises a diffuser interposed between the first and second LCD panels. The diffuser may be adapted to diffuse the light coming from the background light and being
30 transmitted through the second LCD panel before being further transmitted through the first LCD panel. The light diffusion may be due to scattering effects within the diffuser. For example, the diffuser may be a thin foil. Using such diffuser, an image displayed on

the second LCD panel may be blurred relative to an image displayed on the first LCD panel. Blurring across a range of for example 5 pixels (1 – 2 mm) is thought to be adequate without destroying the high resolution demands of specific medical applications. Beneficially, the image displayed on the first LCD panel is sharpened
5 relative to the image displayed on the second LCD panel. As a result, the “perceived” image displayed on the entire dual layer display corresponds to the original image. Blurring the image of the second LCD panel by a diffuser such as a diffusion foil may be significantly less complex than blurring directly the image displayed in the second LCD panel using e.g. known blurring algorithms. Accordingly, the costs for such display can
10 be held reasonable while at the same time obtaining a high resolution, high contrast display having few parallax artefacts.

According to a further embodiment of the present invention, adjacent respective polarizers of the first and second LCD panels are aligned with respect to each other. This may involve aligning the front polarizer of the rear, second LCD panel and
15 the back polarizer of the front, first LCD panel which are facing each other. Since the polarizer on each separate LCD panel are oriented vertically and horizontally, the back panel may have to be mirrored with respect to the front panel to achieve such arrangement in case the liquid crystal panels used for the first and second LCD panels are substantially similar. As is known to a person skilled in the art, the panels can also be
20 oriented diagonally, the main point being that they are aligned.

According to a second aspect of the present invention, a method for driving a display as described above is presented, the method comprising: processing image information of an image to be displayed and controlling the display such that a first portion of the image information is displayed on the first LCD panel and a second
25 portion of the image information is displayed on the second LCD panel; and adjusting a white colour point of the display by further processing the second portion of the image information.

Therein, the step of adjusting the white colour point may be performed, as outlined further above with respect to the embodiments of the inventive display, by
30 predetermining a white colour point or by measuring an actual value of a white colour point value of light transmitted through the second LCD panel and feeding it back to the

control unit. The control unit may then adjust the white colour point, globally or locally, by adjusting the settings to the pixel elements of the second LCD panel.

According to a third aspect of the present invention, a computer program product is presented which is adapted to perform the method according to the above-
5 described second aspect when executed on a computer.

According to a fourth aspect of the present invention, a computer-readable medium is presented having a computer program product according to the third aspect of the invention stored thereon.

It has to be noted that aspects and embodiments of the invention have
10 been described with reference to different subject-matters. In particular, some embodiments have been described with reference to the apparatus type claims whereas other embodiments are described with reference to method type claims. However, a person skilled in the art will gather from the above and the following description that, unless other notified, in addition to any combination of features belonging to one type of
15 subject-matter also any combinations between features relating to different subject-matters, in particular between features of the apparatus type claims and features of the method type claims, is considered to be disclosed with this application.

The aspects and embodiments defined above and further aspects of the present invention may be apparent from exemplary embodiment to be described
20 hereinafter with reference to the drawing but to which the invention is not limited.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 shows the structure of a display according to an embodiment of the present invention.

25 It is to be noted that the drawing is only schematic and not to scale.

DETAILED DESCRIPTION OF THE EMBODIMENT

Fig. 1 shows a display 1 including a first LCD panel 3 and a second LCD panel 5. In the first LCD panel 3, a liquid crystal layer 7 is disposed between an upper
30 and a lower glass plate 9, 11. The liquid crystal layer 7 comprises a multiplicity of pixel elements 13. Above the upper glass plate 9 and below the lower glass plate 11, optical polarizers 15, 17 are disposed. In a similar way, the second LCD panel 5 comprises a

liquid crystal layer 19 disposed between glass plates 21, 23 which themselves are disposed between polarizers 25, 27. The liquid crystal layer 19 comprises pixel elements 29, the size of which is bigger than the size of the pixel elements 13 of the first LCD panel 3. While the first LCD panel 3 is a high resolution black/white LCD panel, the
5 second LCD panel 5 is a low resolution colour LCD panel.

Below the second LCD panel 5, a background light 31 is arranged. The background light 31 uniformly illuminates the rear side of the second LCD panel 5 such that light coming from the background light 31 is first transmitted through the second LCD panel 5 and then through the first LCD panel 3 before being directed to an
10 observer.

Furthermore, the display 1 comprises a diffuser 33 disposed between the first LCD panel 3 and the second LCD panel 5. The diffuser 33 serves for diffusing the light transmitted through the second LCD panel 5 before entering the first LCD panel 3. Thereby, the picture defined by the pixel elements 29 of the second LCD panel 5 is
15 slightly blurred, thereby, on the one hand, preventing parallax effects between the first and second LCD panels 3, 5 and, on the other hand, serving for achieving a more uniform distribution of light emitted from the second LCD panel 5.

In the embodiment of fig. 1, the display 1 further comprises sensor elements 35 which are adapted to measure the intensity and/or the colour of light
20 transmitted through the second LCD panel 5. Having such information from the sensor elements, a white colour point of the display 1 can be adjusted. However, it is to be noted that such sensor elements 35 are only an optional feature of the display 1. In order to calibrate the white colour point of the display, the intensity and/or the colour of light transmitted through the second LCD panel 5 or through the entire display 1 can also be
25 determined e.g. in a previous calibration step using for example external sensor elements or detectors and inputting the measured intensity and/or colour data into a control unit 37 of the display.

The first LCD panel 3, the second LCD panel 5, the background light 31 and the sensor elements 35 are all connected to a control unit 37. This control unit is
30 adapted for driving the first and second panels in a way that an image content to be displayed on the display 1 is divided into a first image to be created by the first LCD panel 3 and a second image to be created by the second LCD panel 5. The entire image

to be displayed by the display 1 is then a superposition of the two images of the first and second LCD panels 3, 5. Therein, the image displayed by the first LCD panel 3 can show finer details as the pixel size of the pixel elements 13 of the first LCD panel 3 is finer than the pixel size of the pixel elements 29 of the second LCD panel 5.

5 While the fine details of an image to be displayed are created by the first LCD panel being a black/white LCD panel, the second display 5 is mainly used to adjust the white colour point of the entire display 1. Therein, the different read, green and blue pixels of the second LCD panel being a colour LCD panel can be addressed by the control unit 37 in such a way that the white colour of light coming from the background
10 light 31 can be modified in order to adjust the white colour point of the entire display 1.

In an additional attempt to provide an intensified understanding of possible purposes, features and advantages of the present invention, aspects of the invention can be described as follows:

Medical imaging standards try to protect the consistency of image
15 information presented at different monitors in order to assure the same or at least essentially same visual input for the medical specialist. This may be reflected in the specific dependence for the luminance versus grey scale of image pixels in case of black-and-white imaging, but also in the colour uniformity across the screen and between screens for coloured imaging case.

20 Herein, the mechanical design of a double layer LCD and possible advantages thereof are described. Particularly, it allows the ultimate contrast and viewing angle which are very much appreciated in medical imaging. The use of a double layer LCD requires also a specific image processing which distributes the image content between two LCD panels. In case of medical imaging, this must be done in a way which
25 results in special luminance and colour response of the resulting superimposed image. It also requires a removal of the so-called "parallax effect", where two spatially separated images could produce an annoying visual doubling at their sharp edges. This can be effectively removed by blurring one of the images displayed on the LCD panels, preferably the image displayed on the rear side, second LCD panel.

30 However, in contrast to a black-and-white display which conventionally does not allow an adjustment of the white colour point of an image, the presented coloured double layer LCD could do so since at least one of its LCD panels has colour

filters in its sub-pixels. The colour adjustment can be done for example by an image processing at pixel-to-pixel level, providing highest colour uniformity.

However, in this context it has to be mentioned that this may take quite a lot of computing power, possibly slowing down the system in the video mode. This
5 might prevent the use of such system for instance in the image-guided surgery. In combination with blurring, colour consistency and prescribed luminance, it puts a limitation on the image in colour or luminance space or in both, this may be simply a result of the discrete mathematics applied to the colour and luminance space. It results in shrinkage of the colour in saturated colour areas and in the skip of grey levels near the
10 white and the black where, usually, much of the medical information is hidden. This limitation may be not a common problem yet but the medical world is rapidly moving to the coloured imaging so that it might become a problem soon.

In order to avoid such first limitation, it is proposed to replace digital blurring of at least one of the images displayed on the first and/or second LCD panel by,
15 instead, using optical diffusion obtained by a diffuser such as a scattering foil. This might greatly speed up the image processing, allowing the high resolution video mode. It can also recover colour and luminance space by replacing the digital blurring of the colour image with the optical diffusion and mixing the sub-pixel colours at the same time. This might improve the colour/luminance space as good such as to allow some colour
20 adjustment around the white colour point without affecting the dynamic range of the imaging.

It should be noted that the term “comprising” does not exclude other elements or steps and the “a” or “an” does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be
25 noted that reference signs in the claims should not be construed as limiting the scope of the claims.

CLAIMS:

1. A display (1) for displaying an image, the display comprising:
a background light (31);
a first LCD panel (3) defining an array of pixel elements (13);
a second LCD panel (5) defining an array of pixel elements (29);
5 a control unit (37) for driving the first and second LCD panels (3, 5);
wherein the second LCD panel (5) is arranged between the first LCD panel (3) and the
background light (31);
wherein the second LCD panel (5) is a color LCD panel; and
wherein the control unit (37) is adapted to control the second LCD panel (5) such that a
10 white color point of the display (1) may be adjusted.
2. The display according to claim 1, wherein
the display (1) further includes sensor elements (35) adapted to measure at least one of
an intensity and a color of light transmitted through the second LCD panel (5).
15
3. The display according to claim 2, wherein
the control unit (37) is adapted to control the second LCD panel (5) such that a white
color point of the display (1) is adjusted automatically based on data measured by sensor
elements (35).
20
4. The display according to one of claims 1 to 3, wherein
the control unit (37) is adapted to control the second LCD panel (5) such that a white
color point of the display (1) is adjusted locally with respect to positions within the two-
dimensional array of pixel elements based on data measured by sensor elements (35) at
25 the respective positions.

5. The display according to one of claims 1 to 4, wherein the control unit (37) is adapted to control the second LCD panel (5) such that a selectable region of the display (1) is highlighted by adjusting the color of the background light (31) transmitted through the second LCD display (5).

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6. The display according to one of claims 1 to 5, wherein the control unit (37) is adapted to process image information of the image to be displayed such that a first portion of the image information is displayed on the first LCD panel (3) and a second portion of the image information is displayed on the second LCD panel (5).

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7. The display according to claim 6, wherein the control unit (37) is adapted to display the first portion of the image with a higher resolution than the second portion.

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8. The display according to one of claims 1 to 7, wherein the second LCD panel (5) has a lower resolution than the first LCD panel (3).

9. The display according to one of claims 1 to 8, further comprising a diffuser (33) interposed between the first and second LCD panels (3, 5).

20

10. The display according to one of claims 1 to 9, wherein adjacent respective polarizers (9, 11, 25, 27) of the first and second LCD panels (3, 5) are aligned.

11. A method for driving a display according to one of claims 1 to 10, the method comprising:
processing image information of an image to be displayed and controlling the display (1) such that a first portion of the image information is displayed on the first LCD panel (3) and a second portion of the image information is displayed on the second LCD panel (5);
adjusting a white color point of the display by further processing the second portion of the image information.

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12. A computer program product which is adapted to perform the method according to claim 11 when executed on a computer.

13. A computer readable medium having a computer program product
5 according to claim 12 stored thereon.

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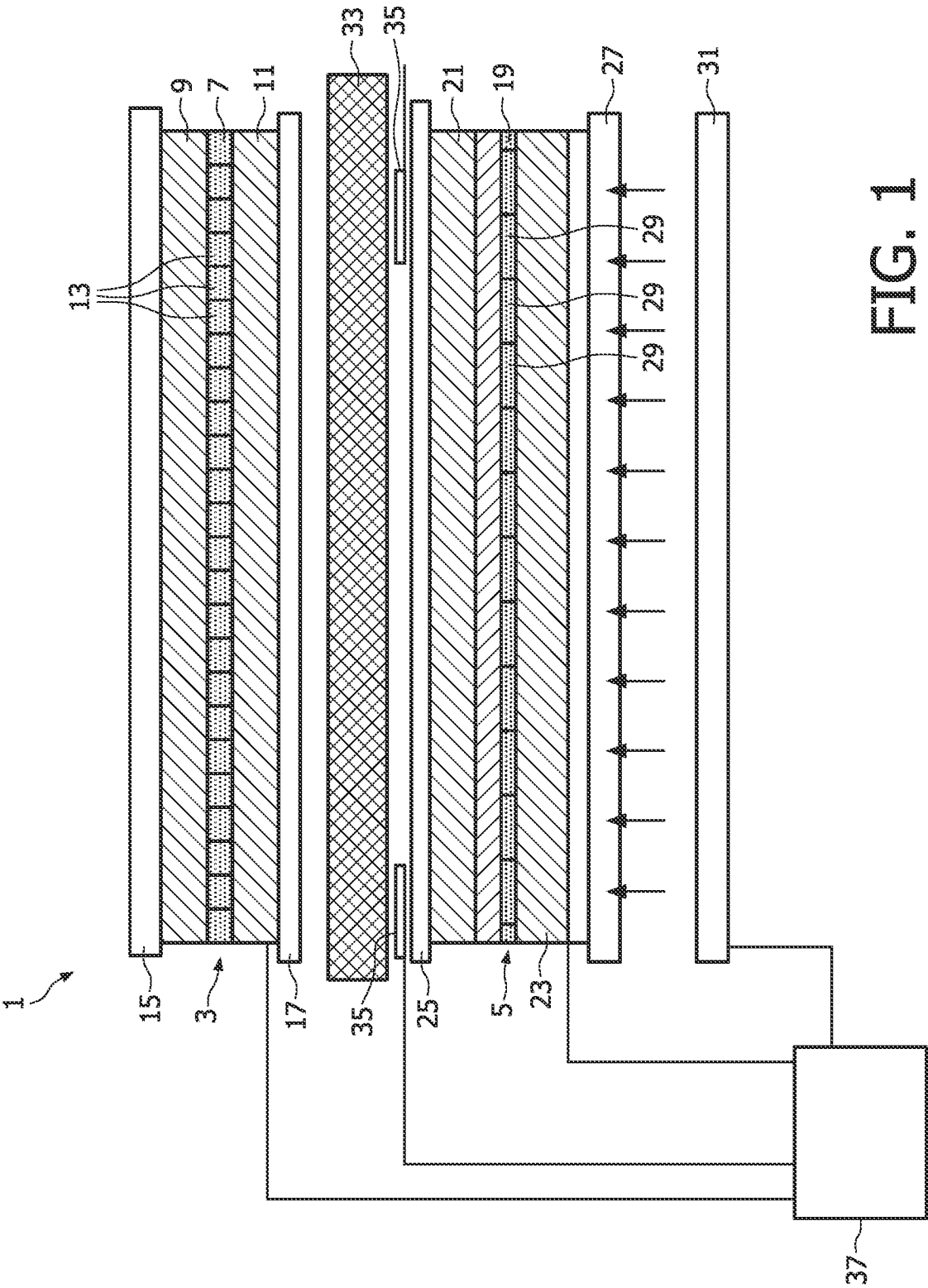


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/051272

A. CLASSIFICATION OF SUBJECT MATTER

INV. G02F1/1347
ADD. G09G3/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G02F G09G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	XU A ET AL: "Display methods for adjustable grayscale and luminance depth" PROGRESS IN BIOMEDICAL OPTICS AND IMAGING - PROCEEDINGS OF SPIE - MEDICAL IMAGING 2008: PACS AND IMAGING INFORMATICS 2008 SPIE US, vol. 6919, 13 March 2008 (2008-03-13), XP002532230 the whole document	1-13
A	WO 2006/056956 A (KONINKL PHILIPS ELECTRONICS NV [NL]; VISSER HUGO M [NL]; JOHNSON MARK) 1 June 2006 (2006-06-01) page 9, line 12 - page 11, line 14 page 15, line 9 figures 3-5	1-13



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
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- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

16 June 2009

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/051272

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	MIYAMOTO T ET AL: "High resolution gray scale medical displays - Technical developments and actual products" NEC TECHNICAL JOURNAL JULY 2006 NEC MEDIAPRODUCTS JP, vol. 1, no. 3, July 2006 (2006-07), pages 70-74, XP002532231 the whole document -----	1-13
A	CARLO CASALE ET AL: "P-32: LED Backlight System for Medical Imaging on LCD Monitors" SID 2007, 2007 SID INTERNATIONAL SYMPOSIUM, SOCIETY FOR INFORMATION DISPLAY, LOS ANGELES, USA, vol. XXXVIII, 20 May 2007 (2007-05-20), pages 306-307, XP007013546 ISSN: 0007-966X the whole document -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2009/051272

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2006056956 A	01-06-2006	CN 101065705 A	31-10-2007
		JP 2008521049 T	19-06-2008
		US 2009146933 A1	11-06-2009

专利名称(译)	高对比度液晶显示屏，白色调点可调		
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[标]发明人	CHESTAKOV DMITRI ROSINK JOHANNES J W M		
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CPC分类号	G02F1/1347 G09G3/3607 G09G2300/023 G09G2320/0261 G09G2320/066 G09G2320/0666 G09G2360/145		
优先权	2008103292 2008-04-01 EP		
其他公开文献	EP2263117B1		
外部链接	Espacenet		

摘要(译)

提出了一种用于显示图像的显示器 (1) 和用于驱动这种显示器的方法。其中，显示器包括：背景灯 (31)，限定像素元件阵列 (13) 的第一LCD面板 (3)，限定像素元件阵列 (29) 的第二LCD面板 (5) 和控制单元 (37) 用于驱动第一和第二LCD面板 (3,5)。第二LCD面板 (5) 是彩色显示器，并且布置在第一LCD面板 (3) 和背景光 (31) 之间。控制单元 (37) 适于控制第二LCD面板 (5)，使得可以调节显示器 (1) 的白色点。优选地，漫射器 (33) 布置在第一显示器 (3) 和第二显示器 (5) 之间。因此，一方面，这种显示器显示出增强的显示特性，例如增加的对比度和视角，而另一方面，通过使用控制单元 (37) 可以根据需要调整显示器的白色点。控制第二LCD面板 (5) 最好是低分辨率彩色显示器。