(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
6 January 2011 (06.01.2011)

PCT

(10) International Publication Number
WO 2011/001372 A1

(51) International Patent Classification:
G02B 27/22 (2006.01) *H04N 13/00* (2006.01)

(21) International Application Number:
PCT/IB2010/052961

(22) International Filing Date:
29 June 2010 (29.06.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09164244.7 30 June 2009 (30.06.2009) EP

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

[Continued on next page]

(54) Title: DIRECTIONAL DISPLAY SYSTEM

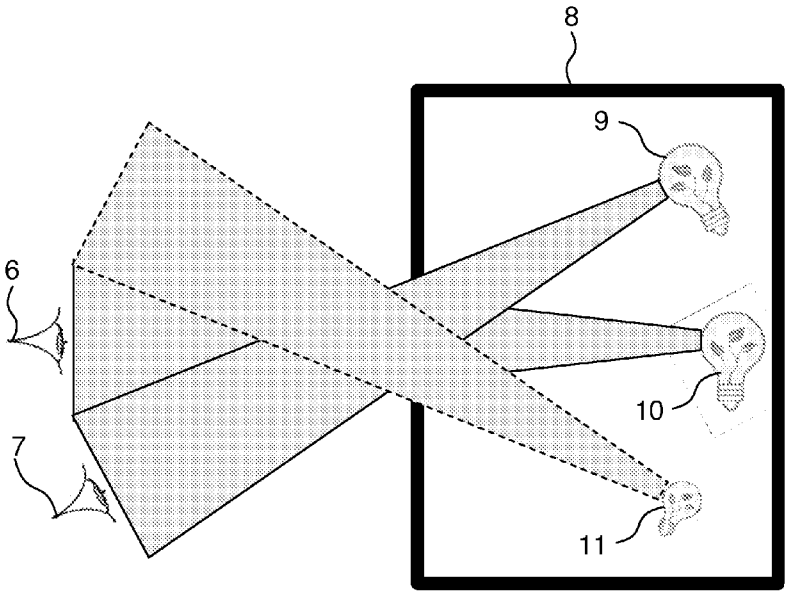

FIG. 2b

(57) Abstract: The present invention relates to a display device, such as a TV screen or an autostereoscopic, i.e. 3D, display, allowing displaying contents only in the directions where viewers are present, and thereby potentially reduce energy or power consumption. This display device combines a viewer detecting system such as an infrared detecting system or a camera and a multi-view directional display, such as PDP, PLED, OLED or LCD. The average power consumption required by this display device (8) is reduced as the content of the display is only displayed towards the angular sections where viewers, (6) and (7), are present.

WO 2011/001372 A1

Published:

— *with international search report (Art. 21(3))*

Directional display system

FIELD OF THE INVENTION

The present invention relates to a display system with reduced light emission and potentially reduced energy consumption.

BACKGROUND OF THE INVENTION

The luminosity output from display devices such as a regular TV, digital photo frame, or computer monitor, (whether CRT or flat screen) is independent of the number of viewers. These display devices are therefore inefficient in that they generate and emit a lot of light into directions from which nobody is watching.

Directional displays which can display different images in different directions are mostly employed in the field of autostereoscopy, which is a technique of displaying three-dimensional (3D) scenes This technique provides depth perception without the need of special prosthesis, e. g. glasses even though the image is reproduced on a flat surface.

Directional displays typically use splitting screen systems, such as lenticular lens arrays or parallax barrier, for producing 3D images. Generally these systems allow correct vision only for one viewer positioned in a fixed location.

Other type of directional displays, e. g. multi-view stereoscopic display, uses dynamic splitting screens to allow 3D vision in wide viewing zones and thereby allowing 3D view for more than one viewer. For example US 2006/0158729 describes an autostereoscopic display device which comprises a pixels display array, a dynamic splitting screen and means for controlling the exit angle of the light emitted by pixels of the display array transmitted through the splitting screen.

In general multi-view directional displays are characterized by a high power consumption dominated by the power needed by the illumination of the display panel, while image processing and sound systems power consumption is, in respect to the total power consumption of the display device, negligible.

Hence, an improved directional display system with reduced power consumption would be advantageous.

SUMMARY OF THE INVENTION

Accordingly, the invention preferably seeks to mitigate, alleviate or eliminate one or more of the above mentioned disadvantages singly or in any combination. In particular, it may be seen as an object of the present invention to provide a display system that solves the above mentioned problems of the prior art by allowing displaying contents only in the directions where viewers are present.

This object and several other objects are obtained in a first aspect of the invention by providing a display system comprising:

i) a directional display for displaying the same content selectively towards two or more angular sections;

ii) a viewer detecting system for detecting presence of viewers in said two or more angular sections;

iii) a control system for said directional display arranged to receive input from the viewer detecting system and, in response to received inputs, to induce said directional display to display the content towards angular sections where viewer presence is detected and to reduce its light intensity towards angular sections where no viewer presence is detected.

In a second aspect, the invention relates to a method for displaying contents selectively towards two or more angular sections, the method comprising receiving inputs regarding the presence of viewers in said two or more angular sections and, in response to said received inputs, displaying a content towards angular sections where viewer presence is detected and reducing the light intensity of or switching off the displayed content towards angular sections where no viewer presence is detected.

In the following, a number of preferred and/or optional features and elements will be described in relation to various aspects and embodiments of the invention. Features or elements described in relation to one embodiment or aspect may be combined with or applied to the other embodiments or aspects where applicable.

It is to be preferred that a backlight luminosity of the directional display can be reduced when reducing the light intensity towards an angular section with no viewer presence. This provides the advantage of reducing the overall power consumption of the directional display.

In the case in which the directional display of the system according to the first aspect of the invention comprises an emissive display, the luminosity of the directional display towards an angular section with no viewer presence can be tuned by varying the resolution of the display.

In some embodiments according to the first aspect of the invention the control system is further adapted to switch off the directional displaying of the content towards a specific angular section where no viewer presence is detected. In these embodiments, the control system turns the displaying of content into an angular section off/on instead of only reducing/increasing its light intensity in case viewer presence is not detected or not detected for a certain period of time.

The angular section is an area or a range of directions in front of the display into which the display can selectively send an image.

Owing to the invention it is possible to detect the presence of a viewer of a directional display in an angular section of the displaying area and in response to the absence of any viewer partially reduce the light intensity or switch off the illumination of the displayed content towards that specific angular section. Advantageously the average power consumption required by the directional display is reduced, as unnecessary illumination towards angular sections where no viewers are present, is avoided.

In a first class of embodiments, according to the first aspect of the invention, the viewer detecting system comprises a camera and a face detector.

High and low resolution cameras, which are able to capture multiple face images in a fixed field of view under non-optimal lighting conditions, are well know and available on the market. These viewer detecting systems use a special algorithm to parse the scene and look for the features of a human face. Upon detection of viewers the camera supplies inputs to the receiving control system.

In a second class of embodiments of the system, according to the first aspect of the invention, the viewer detecting system comprises a directional infrared detector.

Infrared detectors have the advantage of being able to operate and detect the presence of a viewer in the angular section of interest also when background lighting in the room is particularly dimmed. Generally the display of images is carried in dark ambiance or where the intensity of the background lighting is very low, thereby infrared viewer detecting systems may be preferred as more sensitive in these particular light condition. One example of infrared sensitive system may be an eye tracking system that uses infrared and near-infrared non-collimated light to create a corneal reflection in the eyes and thereby detect eyes movement of a viewer.

In one embodiment, the control system switches on or off the directional display on the basis of the inputs received from the viewer detecting system. For example upon detection of no viewers the viewer detecting system provides inputs to the control

system which switches off the directional display that was previously on. On the contrary upon detection of viewers the viewer detecting system provides inputs to the control system that switches on the directional display which was previously off. There may be some asymmetrical behavior in the control system such that the directional image is switched on immediately after a viewer is detected, while it only switches off, or reduces slowly, after finding no viewer for a certain period of time.

In some embodiments the system for displaying visual contents according to the first aspect of the invention further comprises two or more backlight sources for the directional display for generating light to be displayed towards the two or more angular sections, respectively, which can be switched off or dimmed. These backlight sources are preferably located in opposite directions of the two or more angular sections towards which they display light.

In this embodiment displaying contents selectively towards two or more angular sections is achieved by controlling the light emission of the backlight sources of a directional display which are located in opposite direction of the mentioned angular sections. By selectively switching on or off the backlight sources, the displayed content towards the different angular sections can be selectively switched on or off.

In some other embodiments the directional display of the display system according to the first aspect of the invention comprises a spatial light modulator and a lenticular lens array located in the front and a lenticular lens array located in the back of said spatial light modulator. A number of embodiments of the directional display are described later, in relation to the Figures.

In some other embodiments the directional display system according to the first aspect of the invention comprises an emissive display with only a lenticular lens array mounted at the front of the display panel. Examples of are emissive displays are Polymer Light Emitting Diodes (PLED), Organic Light Emitting Diodes (OLED).

This object and several other objects of the invention are obtained in a second aspect by providing a method for displaying contents selectively towards two or more angular sections utilizing a system according to the first aspect of the invention.

The basic idea of the invention can be formulated as to reduce the luminosity of a display device into angular sections where no viewer is present. Thereby, the overall power consumption of the display device may also be reduced.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE FIGURES

The present invention will now be explained, by way of example only, with reference to the accompanying Figures, where

Fig. 1 is a schematic drawing of a display system for directionally displaying contents selectively towards two or more angular sections according to an embodiment of the present invention.

Fig. 2a and Fig. 2b illustrate the basic principles of a display system for directionally displaying contents selectively towards two or more angular sections according to an embodiment of the present invention.

Fig. 3 is a schematic drawing of an embodiment of a directional display employing lenticular lens arrays according to an embodiment of the present invention.

Fig. 4 is a schematic drawing of an embodiment of a directional display employing a lenticular lens arrays according to an embodiment of the present invention where the directional display is an emissive display.

Fig. 5 is a schematic drawing of an embodiment of a directional display employing backlight illumination having different angles of origin.

Fig. 6 is a flow-chart of a method according to an embodiment of the invention.

The Figures are not drawn to scale. Generally, identical components are denoted by the same reference numerals in the Figures.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Fig. 1 is a schematic drawing of a display system 1 for directionally displaying contents selectively towards two or more angular sections according to an embodiment of the present invention. The system comprises a viewer detecting system 3, such as a directional infrared detector or a camera coupled to a face detector, a directional display 4 and a control system 2. The control system 2 is arranged to receive input from the viewer detecting system 3 and, in response to these received inputs, to provide opportune inputs to the directional display 4 so that:

i) when viewer presence is detected by viewer detecting system 3 the directional display 4 displays its content towards angular sections where viewer presence is detected; and

ii) when no viewer presence is detected or not detected for a certain period of time in an angular section by viewer detecting system 3, the directional display 4 partially reduces the light intensity or switches off the illumination towards angular sections where no viewer presence is detected.

Generally directional display devices comprise a source of collimated light, a switchable light modulator and a splitting screen which control the exit angle of the displayed image. An example of a switchable light modulator is a Liquid Crystal Display (LCD) pixel array. Collimating light is an operation well known to persons skilled in the art, and may be applied to most of the known matrix display devices. For example a light collimator can be positioned between a continuous source of light, e. g. a backlight of an LCD matrix display, and the switchable light modulator, e. g. the LCD pixel array of an LCD display device, or between the switchable light modulator and the splitting screen. Example of splitting screens are lenticular lens screens having a plurality of cylindrical lenses arranged, in respect to the pixels of the display array, so that the collimated light of a pixel enters a lens and exit the lens under a deflection angle. The control of the curvature of the lens array provides control of the angular section from where the pixel is visible.

Fig. 2a and Fig. 2b illustrate the basic principles of a display system for directionally displaying contents selectively towards two or more angular sections according to the present invention.

A directional display, according to an embodiment of the invention, allows several viewers to simultaneously view the displayed content. For example Philips high definition (HD) autostereoscopic displays using WOWvx technology allow for multiple viewers to simultaneously view 3D contents without the need of glasses.

In Fig. 2a a directional display 8 displays a content towards three viewers 5,6 and 7. The angular sections, towards which the directional display 8 displays its content, are indicated by the control system (not shown) upon the detection of the viewers 5, 6 and 7 by the viewer detecting system (not shown). In Fig. 2a and Fig. 2b the light intensity of the displayed content in each angular section is generated by a means for providing directional back lighting (e.g. different backlight sources or one backlight source and a lencticular array, these will be described later in relation to Figs. 3 and 4). The directional back lighting is emitted towards corresponding angular sections. In these Figures, the means for providing directional back lighting are schematically simplified for convenience and represented by the bulbs 9, 10 and 11. In this representation, the dimension of the bulbs is shown relatively proportional to the light intensity, i. e. the higher the light intensity, the bigger the bulb.

Thereby in Fig. 2a the light intensity of the content displayed towards the three angular sections where viewer 5, 6 and 7 are located, respectively represented by bulb 11, 10 and 9, has the same value.

In Fig. 2b upon detection, by the viewer detecting system (not shown), of the absence of viewer 5, the control system (not shown) indicates to the directional display 8 the opportune response which is the partial reduction or eventually the total reduction, i. e. the switch off, of the light intensity of the content displayed towards the angular section where viewer 5 was previously located. This reduction in light intensity is represented in Fig. 2b by the reduction of the dimension of bulb 11 in respect to its previous dimension in Fig. 2a. The light intensity of the content displayed towards angular sections where viewers 6 and 7 are still located is maintained as shown by the dimensions of bulbs 9 and 10.

Fig. 3 is a schematic drawing of an embodiment of a directional display employing lenticular lens arrays according to an embodiment of the present invention. In this embodiment the directional display is formed by an LCD pixels array 14 sandwiched between two lenticular lens arrays, 13 and 15, respectively located in the front, i. e. lenticular lens array 15 towards viewer 6, and in the back, i. e. lenticular lens array 13 towards the source of backlight 12, of the LCD pixels array 14. Upon illumination from the backlight 12 the presence of the lenticular lens array 13 allows for selective illumination of different areas of the LCD pixel array 14. This selective illumination provides through the lenticular lens array 15 selective direction of light towards different angular sections with viewers 5 and 6.

The directional display in Fig. 3 may potentially allow for a reduction in power consumption. When, for example, viewer 5 leaves his/her angular section, the luminosity previously directed towards this angular section can now either be blocked or be directed towards the only angular section where a viewer 6 is present. This “turning of the light” from angular section of viewer 5 to angular section of viewer 6 may be performed by controlling lenticular lens arrays 13 and 15. If not accompanied by an overall reduction of the backlight luminosity, this would result in an increased luminosity as seen by viewer 6, which is not desirable. The control system will therefore preferably induce a corresponding overall reduction of the luminosity generated by the backlight 12, to keep the luminosity towards viewer 6 at least substantially constant. This means a reduced power consumption for backlight 12.

Fig. 4 is a schematic drawing of an embodiment of a directional display employing a lenticular lens arrays according to an embodiment of the present invention where the directional display is an emissive display. In this embodiment the directional

emissive display is formed by e. g. an OLED, having a lenticular lens array 15 located in the front of the display array 14. The lenticular lens array deflects over an angle range the light emission from the OLED towards different angular sections where for example viewers 5 and 6 are present.

The directional display in Fig. 4 may potentially allow for a reduction in power consumption. When, for example, viewer 5 leaves his/her angular section, the luminosity previously directed towards this angular section can now be directed towards the only angular section where a viewer 6 is present. This "turning of the light" from angular section of viewer 5 to angular section of viewer 6 may be performed by controlling lenticular lens array 15. If not accompanied by an overall reduction of the backlight luminosity, this would result in an increased luminosity as seen by viewer 6, which is not desirable. The control system will therefore preferably induce a corresponding overall reduction of the luminosity generated to keep the luminosity towards viewer 6 at least substantially constant. This means a reduced power consumption for the display 14.

Fig. 5 is a schematic drawing of an embodiment of a directional display employing multiple directive backlight illumination. In Fig. 5 an LCD pixels array 19 is illuminated by backlights 16, 17 and 18 which provides different directions of illumination of the LCD pixels array and thereby allowing the directional display to selective display contents towards different angular sections.

Upon detection, by the viewer detecting system (not shown), of the sole presence of viewer 6 the control system (not shown) provides the reduction of light intensity and eventually the switch off of the illumination originating from backlights 16 and 18, as shown by the presence of dashed arrows.

Fig. 6 is a flow-chart of a method for displaying the same content selectively towards two or more angular sections according to an embodiment the invention. The method comprises receiving inputs S1 regarding the presence of viewers in these two or more angular sections and, in response to said received inputs, displaying a content S2 towards angular sections where viewer presence is detected and reducing the light intensity of S3 or switching off S4 the displayed content towards angular sections where no viewer presence is detected.

When turning the display system on, several scenarios are possible, here referring to Fig. 5. In a first scenario, the presence of viewers is detected first, and then the control system causes directional display is turned on, with full intensity towards angular sections with viewer presence (backlight 17 is turned on with full luminosity), and reduced or

no luminosity towards angular sections with no viewer presence (backlight 16 and 18 not turned on, or turned on with reduced luminosity).

In a second scenario, all backlights are turned on first, and the detection of viewer presence in the different angular sections is performed thereafter. Next, the reduction or turning of angular sections with no viewers, according to the method described in relation to Fig. 6, is performed.

Although the present invention has been described in connection with the specified embodiments, it is not intended to be limited to the specific form set forth herein. Rather, the scope of the present invention is limited only by the accompanying claims. In the claims, the term “comprising” does not exclude the presence of other elements or steps. Additionally, although individual features may be included in different claims, these may possibly be advantageously combined, and the inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. In addition, singular references do not exclude a plurality. Thus, references to "a", "an", "first", "second" etc. do not preclude a plurality. Furthermore, reference signs in the claims shall not be construed as limiting the scope.

CLAIMS:

1. A display system comprising

- a directional display for displaying the same content selectively towards two or more angular sections;
- a viewer detecting system for detecting presence of viewers in said two or more angular sections;
- a control system for said directional display arranged to receive input from the viewer detecting system and, in response to received inputs, to induce said directional display to display the content towards angular sections where viewer presence is detected and to reduce its light intensity towards angular sections where no viewer presence is detected.

2. A display system according to claim 1 wherein said control system is further adapted to switch off the directional displaying of the content towards a specific angular section where no viewer presence is detected.

3. A display system according to claim 1 wherein said viewer detecting system comprises a camera and face detector.

4. A display system according to claim 1 wherein said viewer detecting system comprises a directional infrared detector.

5. A display system according to claim 1, further comprising two or more backlight sources for the directional display for generating light to be displayed towards the two or more angular sections, respectively, which can be switched off or dimmed.

6. A display system according to claim 1, wherein the directional display can reduce luminosity generated by one or more backlight sources when reducing the light intensity towards an angular section with no viewer presence, and thereby reduce its overall power consumption.

7. A display system according to claim 1 wherein said directional display comprises a spatial light modulator and a lenticular lens array located in the front and a lenticular lens array located in the back of said spatial light modulator.

8. A method for displaying contents selectively towards two or more angular sections utilizing a system according to claim 1.

9. A method for displaying contents selectively towards two or more angular sections, the method comprising receiving inputs regarding the presence of viewers in said two or more angular sections and, in response to said received inputs, displaying a content towards angular sections where viewer presence is detected and reducing the light intensity of or switching off the displayed content towards angular sections where no viewer presence is detected.

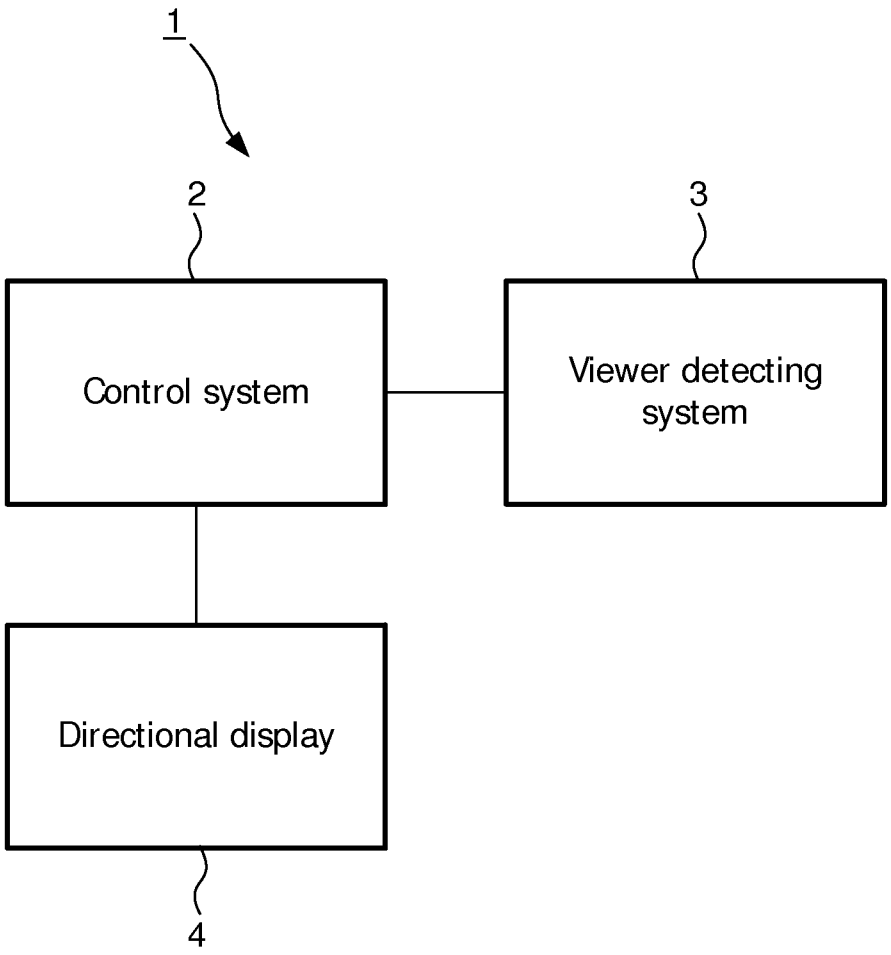
1
2
3
Control system
Viewer detecting system
Directional display
4

FIG. 1

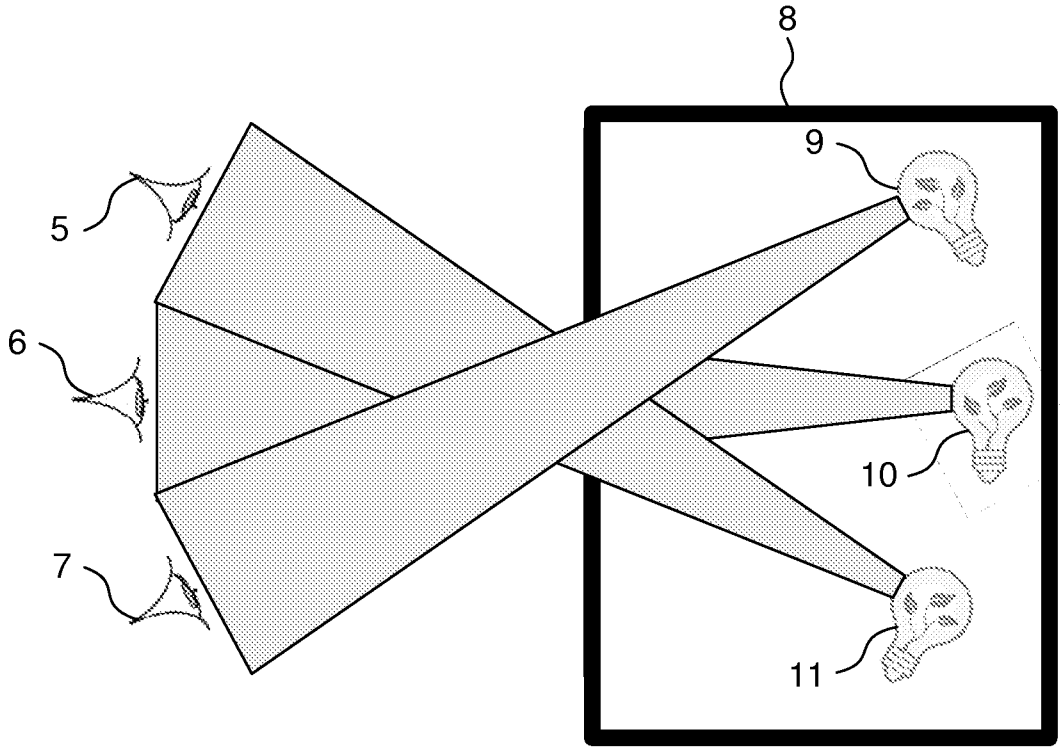

FIG. 2a

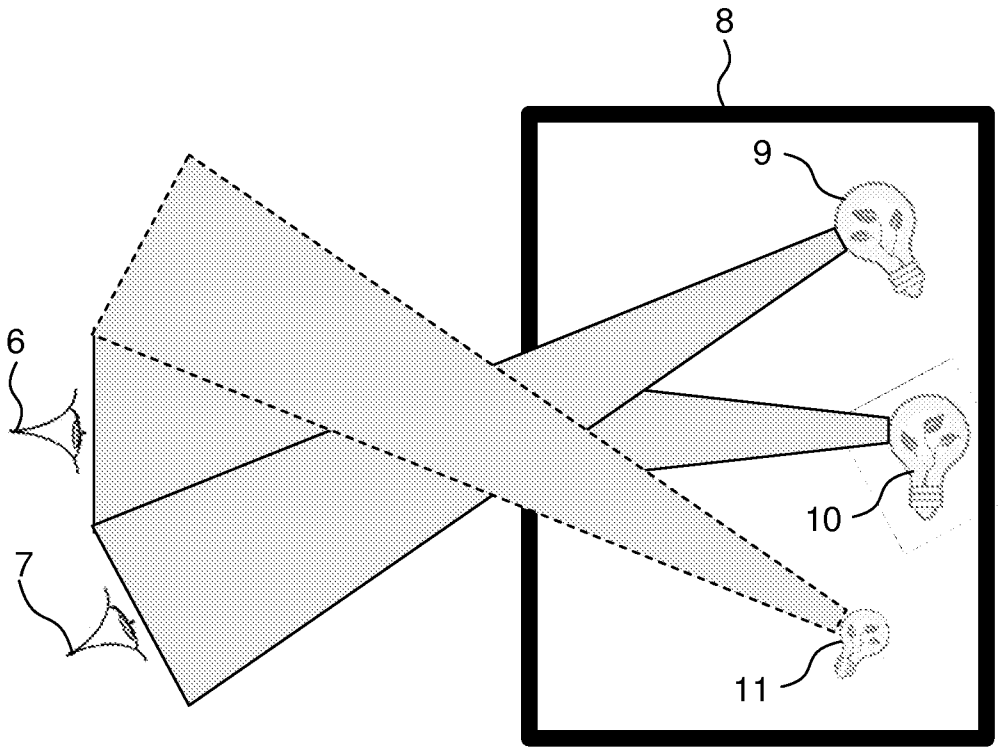

FIG. 2b

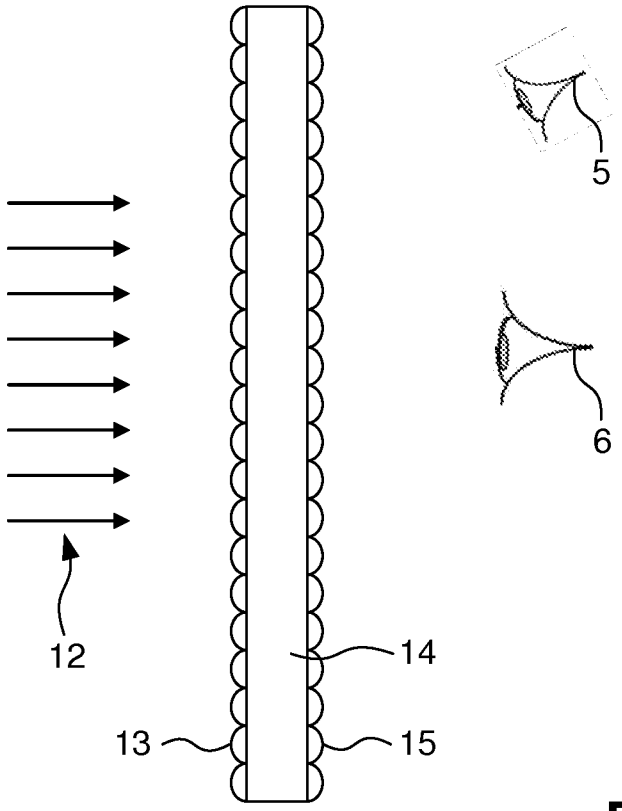

FIG. 3

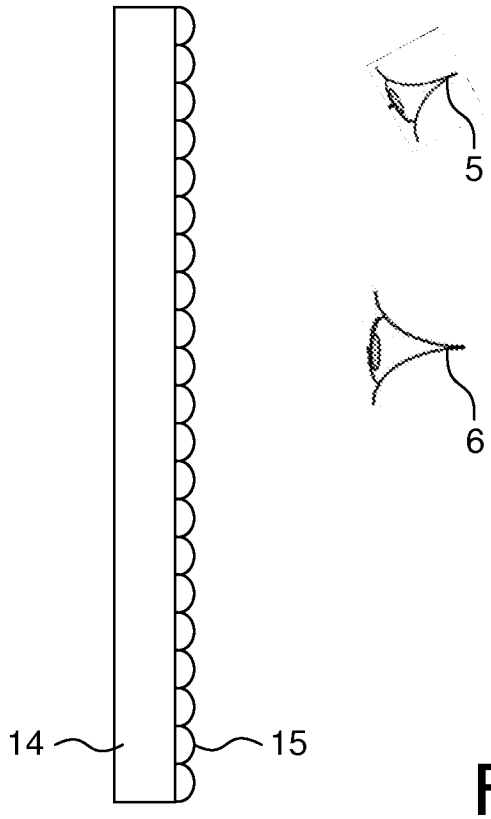

FIG. 4

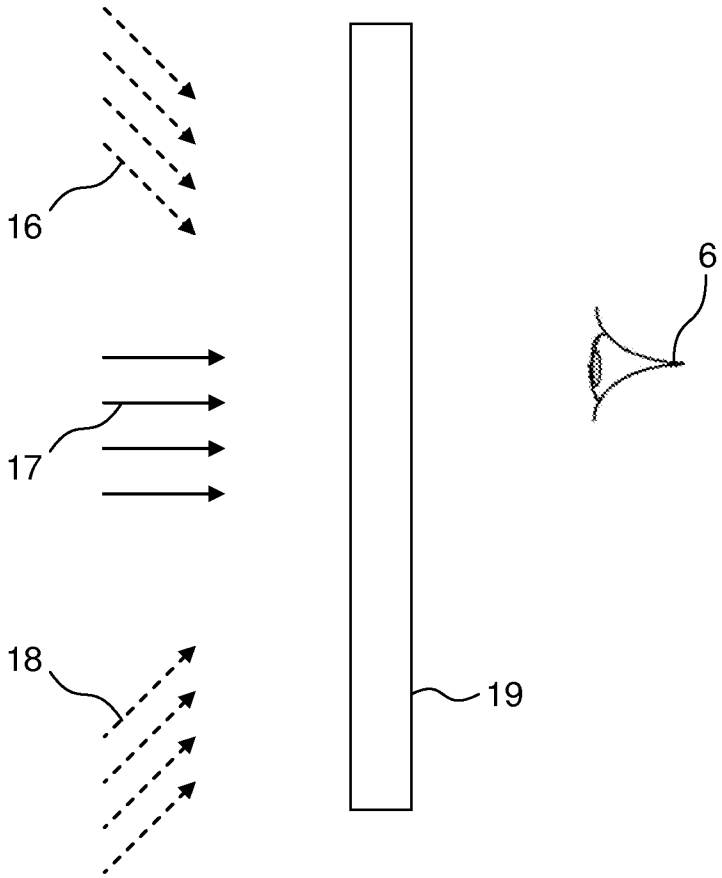
16
17
18
19
6

FIG. 5

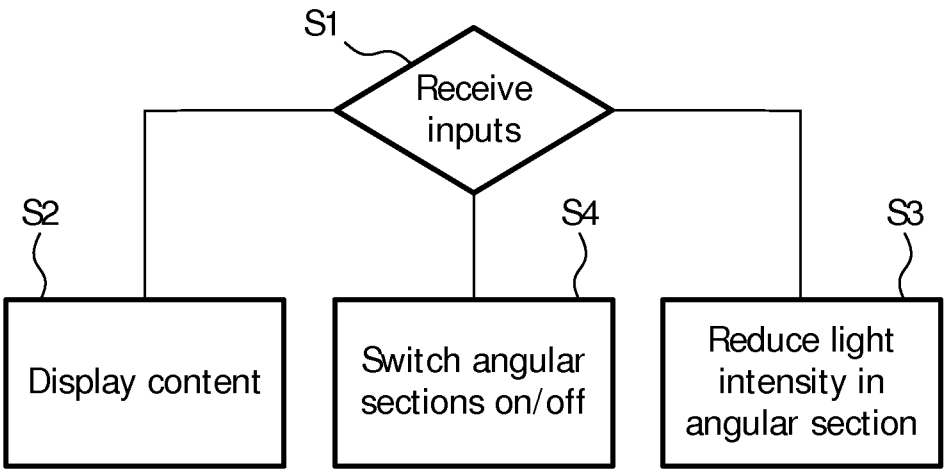
S1
Receive inputs
S2
S4
S3
Display content
Switch angular sections on/off
Reduce light intensity in angular section

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/052961

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B27/22 H04N13/00
ADD.

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)
G02B H04N

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	EP 1 808 845 A1 (FUJITSU TEN LTD [JP]) 18 July 2007 (2007-07-18) paragraph [0059] - paragraph [0063]; figure 12 paragraph [0116]	1-4,7-9 5,6
Y	EP 1 001 299 A1 (THOMSON MULTIMEDIA SA [FR]) 17 May 2000 (2000-05-17) * abstract	5
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A	EP 0 804 042 A2 (FUJITSU LTD [JP]) 29 October 1997 (1997-10-29) * abstract page 19, line 23 - page 23, line 54; figures 62A-62C	1,8,9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 September 2010	14/10/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Lehtiniemi, Henry

INTERNATIONAL SEARCH REPORT

Information on patent family members

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