

(51) International Patent Classification:
G06T 5/00 (2006.01)(21) International Application Number:
PCT/GB2014/050696(22) International Filing Date:
10 March 2014 (10.03.2014)

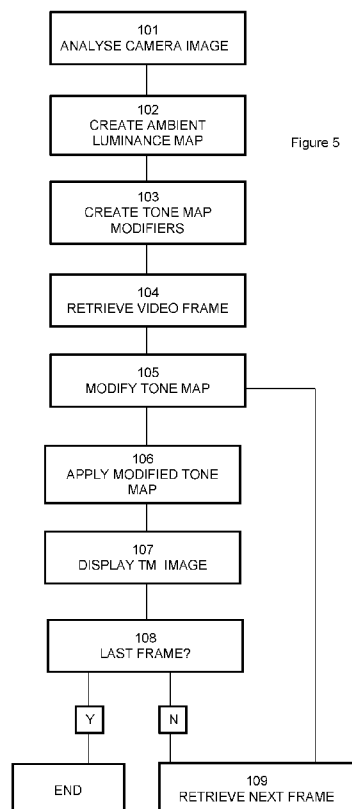
(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
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London, EC4Y 8JD (GB).(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, BN, 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, IR, IS, JP, KE, KG, 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, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
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.

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(54) Title: HIGH DYNAMIC RANGE IMAGING SYSTEMS



(57) Abstract: A method for tone mapping a high dynamic range image to be presented on a display device (15). The display device is provided with a camera (17) which captures an image indicating ambient light levels experienced at a number of positions over the display (16) of the device. A data processing module (22) processes signals from the camera and generates data which is used in adapting a tone mapping function applied to the high dynamic range image so as to account for different ambient light conditions. The data processing module may take into account different lighting conditions at different positions on the display when generating the data which is used in adapting the tone mapping function. The data processing module may also use signals from a camera (20) on the other side of the device and / or from an orientation detection module (21). The data processing module may also use preference data supplied for a series of video frames, when adapting the tone mapping function. The device may be a mobile phone, a table computing device or a portable computer.



(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, 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, RS, SE, SI, SK,

SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

High Dynamic Range Imaging Systems

This invention relates to high dynamic range imaging systems.

5 A human being can distinguish objects both in starlight during night time or in bright sun light, even though on a moonless night objects receive only approximately 1/1,000,000,000 of the illumination they would on a bright sunny day: This corresponds to a dynamic range of 90 db. However, the eye needs time to adjust to different light levels. Thus, the dynamic range of the human eye without adjustment
10 of the pupil is only approximately 30 db. By contrast, the differences between very dark and very light spots in a picture taken by a modern camera system can easily be larger than those the human eye can distinguish without adaptation; with a modern camera system it is thus possible to determine fine details in very dark spots even while very bright spots are also present in a picture. The dynamic range
15 of a modern camera system may also easily surpass the dynamic range of a conventional display.

Tone mapping has been developed as a way for adapting images recorded with a high dynamic range camera, or generated by a computer, to match the limitations of
20 a display. Tone mapping is very helpful in the production of realistic images and several operators have been proposed. Two main tone mapping operator classes exist, namely tone reproduction curves (TRCs) and tone reproduction operators (TROs). Both will be referred to as tone mapping functions in the present application.

25 TRC algorithms are efficient because the operation is applied to pixels independently and thus can be performed in parallel using a simple look-up table. In addition, models also exist that are able to capture some important aspects, such as visual adaptation. However, TRCs fail to capture the important information on
30 local contrast that could be represented in the spatial context of neighbouring image pixels which is of great importance for the human visual system.

The algorithms based on TROs when compared with TRCs are able to capture the important information on local contrast. Unfortunately, they typically introduce

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artefacts in some parts of the image, such as dark halos, and are computationally more demanding.

5 It should be noted that the viewing conditions of an observer looking at a display may be completely different and can affect the appearance of the image. In *Display Adaptive Tone Mapping* by Rafał Mantiuk, Scott Daly and Louis Kerofsky, ACM Transactions on Graphics (Proc. of SIGGRAPH'08), 27(3), article no. 68, 2008, there is proposed the concept of tone-mapping closely coupled with a display device, which renders images optimized for a particular display and under the
10 existing viewing conditions (ambient light). It is stated that a mobile phone should change its rendering algorithm when the backlight of its transreflective display is switched off to save power and that a TV display should adjust the display algorithm when light in the room is lit. It is noted that simple dimming due to ambient illumination is already performed in some TV displays.

15 One object of the systems disclosed herein is to improve the adaptability of tone mapping in accordance with ambient light. When viewing high dynamic range (HDR) images on a display, the content of the scene depicted can change dynamically, as can the ambient lighting conditions, particularly when viewing the
20 content on a mobile device, whilst on the move. There is thus a need for a tone mapping operator (TMO) framework that can dynamically take into account both the scene being considered and the current environmental conditions to ensure a preferred user viewing experience.

25 Viewed from one aspect there is disclosed a method for tone mapping a high dynamic range image to be presented on a display, wherein there is associated with the display an imaging device which captures an image indicative of ambient light levels experienced at a number of positions over the display, and a data processing module processes signals from the imaging device and generates data
30 which is used in adapting a tone mapping function applied to the high dynamic range image so as to account for different ambient light conditions.

Preferably, adapting a tone mapping function applied to the high dynamic range image so as to account for different ambient light conditions, is done dynamically.

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The use of an imaging device, as opposed to a simple light sensor, provides greater versatility in adapting the tone mapping function. For example, the system could take into account different lighting conditions at different positions on the display. Thus, for example, if the captured image indicates that one portion of the display on a portable device such as a mobile telephone or a tablet computer will be in bright sunlight whilst another portion of the display will be in shade (for example from a body part of a user holding the device), the tone mapping function can be adapted so that different parts of the image are treated differently, depending on whether they are in bright light or in shade. Thus, in preferred embodiments of the invention, the tone mapping function applied to the high dynamic range image is adapted so as to account for different ambient light conditions at different positions on the display.

The imaging device could be used and an average value of luminance values then calculated, which is used to adapt the overall tone mapping function, as opposed to adapting it on a position dependent basis. There will be a plurality of possible average luminance values, between a simple light off value and a simple light on values. This provides for more detailed adaptation of the tone mapping than a simple on off arrangement as disclosed in *Display Adaptive Tone Mapping* by Rafal Mantiuk et al.

The captured image will not be an image of the display itself, but an image captured by an imaging device looking away from the display, typically from a position adjacent the display.

In some embodiments of the invention, there may be a plurality of imaging devices, and a corresponding plurality of images are captured at any given time. These may, for example, cover different areas of the display although the area captured by the devices may overlap. The plurality of images can be combined to create a single image covering the entire display, and methods for combining images are well known in the art.

In another embodiment, there may be a plurality of imaging devices which are directed in opposite directions. One or more imaging devices can capture an image or images indicative of ambient light levels experienced over the display, whereas

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one or more imaging devices can capture an image or images which can be used to detect other environmental conditions which affect the tone mapping required. For example, on a mobile telephone or a mobile tablet device there may be a camera on the front of the device directed at the user which can, for example, be used to
5 take a self-portrait and this can be used to detect the ambient light levels experienced over the display. However, there is frequently provided a camera on the back of the device which is used to take photographs of other subject matter. This can be used, for example, to detect the amount of light on the other side of the device. It can be used, for example, with the orientation detecting module, such as
10 an accelerometer often found in mobile devices, to detect the orientation of the device, for example whether the user is looking down onto the device (with, typically, a dark surface beneath the device) or holding it up (with typically the sky or artificial lighting behind the device). In any event, with a portable device - typically hand held - the area around the device will be in the field of view of the
15 user, and lighting conditions on the other side beyond the device can affect how the user's eyes respond.

According to another aspect of the invention, there is provided a method for tone mapping a high dynamic range image to be presented on portable device, the
20 device having a front and a back and on the front of the device there is a display on which the image is to be presented, on the front of the device there is also a first camera directed away from the screen which captures first image data which indicates ambient lighting conditions, and on the back of the device there is a second camera directed away from the back which captures second image data
25 which indicates ambient lighting conditions, and a data processing module processes signals from the first and second cameras and generates data which is used in adapting a tone mapping function applied to the high dynamic range image so as to account for different ambient light conditions as detected by both the first and second cameras.

30 In some preferred embodiments the tone mapping is adapted dynamically, so that the imaging device captures images continually, and as the lighting conditions change the tone mapping function changes. By "continually" it is not implied that the imaging device captures frames at interval sufficiently closely spaced to be usable

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as a video. The frames may be captured at more widely spaced intervals, which may be regular or irregular.

5 The quality of the image that is captured need not be of high enough resolution for use as a photograph or a video, but can be of significantly lower resolution. A lower resolution image will require less processing time and speed for the tone mapping function to be adapted. The captured image could be in greyscale only, to further reduce the processing required. However, the captured image could be in colour so that the tone mapping function can be adapted for, e.g., coloured ambient light. The
10 number of colours captured may be limited, and substantially below that necessary for a photograph or a video.

However, the imaging device could be in the form of a camera. As noted above, mobile telephones, tablet computing devices and portable computers include a
15 camera on the display side, intended to be used to capture an image of the user. In some cases, desktop computer displays are provided with a camera facing a user or can be provided with such a camera (frequently referred to as a "web cam"). For other display devices, a separate camera may be provided, if the facility exists to provide an interface, or the display device may be modified to provide an image
20 capture function. For a TV display which is currently provided with a simple light sensor may detect whether room lights are on or off, a more sophisticated imaging device could be provided.

25 The image to be displayed and subjected to tone mapping could be a still image, or a video. Where there is a video, or a series of still images, the tone mapping functions can be adapted to account for different conditions as there are changes from scene to scene, or for example if there are different lighting conditions as a camera pans across a view.

30 Adapting the tone mapping function also encompasses selecting different types of tone mapping function for particular circumstances.

In embodiments of this aspect of the disclosure, the tone mapping function will vary according to the nature of the image, the capabilities of the image processing
35 equipment that will handle the image, the capabilities of the display, the lighting

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conditions where the image is displayed and any other variables which affect the way the displayed image is perceived by a viewer.

5 In some embodiments of the invention, processing of data from the imaging device and adapting the tone mapping function are carried out within a device providing the display. However, in some cases data from the imaging device, or locally processed data from the imaging device, can be fed to a server which supplies images to the display and can carry out the tone mapping. When a server is used, the tone mapping is adapted individually for the target display in accordance with
10 the data from the imaging device associated with that imaging device.

In addition there is also a need for a tone mapping operator (TMO) framework that can dynamically take into account both the scene being considered and the current environmental conditions to ensure that the creative intent of the person who
15 produced the content is delivered to the user whatever the current environmental conditions.

In accordance with another feature of this disclosure, the tone mapping may be adapted in accordance with the wishes of a person responsible for the appearance
20 of the image, such as a director responsible for the appearance of scenes of a movie or other video. Such a person can define a particular theme or mood to be applied, and the tone mapping will reflect that theme or mood. For example, the director may decide that a particular scene should have a blue tint. The data being fed to the device which drives the display, may include some data which reflects the
25 director's preferences. By way of example, the director can look at a scene of a video on a monitor display, and alter colour correction so that a scene appears in a particular way that the director wishes. Having done that, the video can be colour corrected and stored in this corrected form. However, the director will have made decisions based on the appearance of the scene on the particular monitor display
30 under certain ambient lighting conditions, and there can be no guarantee that there will be the same effect when the scene is viewed on another display in different lighting conditions. According to this aspect of the disclosure, the image data includes preference data which enables a tone mapping function which adapts the image data for display on a given display, to take into account the preferences of a
35 parson responsible for producing the video data.

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By way of example, there could be a "standard" display device and "standard" lighting conditions, so that other display devices and the conditions in which they are being viewed can be compared to this. A director can view a scene and choose a particular mood - for example choosing a particular frame which has an appearance which bests fits the mood the director wishes to create. Data can be generated which would generate that appearance on the "standard" display device under the "standard" lighting conditions, and this can accompany the video data as signifying preferences for a scene. For example the colour appearance of the chosen frame can be determined compared to a predetermined "standard" colour chart, the display characteristics are known from the display specifications and its current settings (such as the current contrast setting), while the current environmental conditions can be determined by a imaging device as described above.

At a destination device for the video data, tone mapping will be used in a conventional manner, or as described earlier to account for different ambient lighting conditions over the display, and also to reflect the preferences for a particular scene. Preferences could be set for any number of scenes, and in this context a scene includes a series of frames of any length. A director could choose preferences for an entire film. In any event, the preferences of the director will be reproduced whatever other changes tone mapping may cause to take place.

The aspect of the disclosure can be used in its own right and thus viewed from another aspect there is provided a method of tone mapping of a stream of images forming a video, wherein at least a series of those images is provided with preference data, and that preference data is used to adapt the appearance of the images in the series during tone mapping.

The preference data may be encoded together with the video. The preference data could also be sent in the form of meta data rather than as example video frames. This meta data - describing the conditions when the preference was created - would be a lot smaller (and then of course much easier to transmit) than a sequence of video frames. Example video frames could also be sent but these would have to be

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interlaced within the HDR video stream (although they would themselves be tone mapped images and thus smaller than an HDR video frame.)

5 Embodiments of the invention provide a tone mapping framework that can dynamically take into account both the scene being considered and the current environmental conditions to ensure a preferred user viewing experience.

10 The present invention proposes a tone mapping framework that is dynamic and providing the tone mapping operator and parameters for a preferred viewing experience based on the current ambient environmental conditions, such as natural or artificial lighting conditions, and the current frame being watched. The preferred framework is reactive and changes the choice of tone mapping operator as the ambient lighting conditions change and the scene being watched changes.

15 Embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which:

20 Figure 1 is a diagrammatic view of a display device in a domestic environment, during daylight;

 Figure 2 is a diagrammatic view of the display device in the same domestic environment, at night;

25 Figure 3 is a diagrammatic view of the display device, showing how a shadow is formed on the screen;

 Figure 4 shows a map for the screen, illustrating the area corresponding to the shadow;

30 Figure 5 is a block diagram showing a process in accordance with the invention;

 Figure 6 is a block diagram of a routine for adapting the process if there is a change in ambient luminance;

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Figure 7 is a schematic representation of a system which introduces the ability to take into account preferences;

Figure 8 is a front view of a portable device which can be used in accordance with the invention: and

Figure 9 is a rear view of the portable device of Figure 8.

In Figure 1 there is show a display device 1 for a domestic or office environment, such as a television or a monitor for a computer, having a screen 2. The display device is also provided with an imaging device 3, which in this case is a camera, which captures ambient light impinging on the screen, although more than one imaging device could be provided. There is a window 4, through which the environment is lit by daylight, as indicated by 5. Within the environment there is also an artificial light 6, which is turned off. In this environment the screen 2 is illuminated evenly.

Figure 2 illustrates the environment of Figure 1, at night time. Outside it is dark, as indicated at 7, and less light passes through the window 4. This provides little ambient illumination across the screen 2. In this case, the artificial light 6 is illuminated and this illuminates the screen, with the maximum illumination being in the region marked 8.

The process in accordance with the invention, as described in more detail below, aims to provide a similar viewing experience of HDR material on the screen 2, in both the environments of Figures 1 and 2.

Figure 3 shows an object 9 placed in front of the display device 1, which is illuminated as indicates at 10, so that a shadow is cast on the screen. The imaging device 3 captures an image if the ambient light impinging on the screen and can detect that the light source 10 is partially blocked by the object 9. Figure 4 shows a map 12 of the screen, divided into regions by a grid 13. These could be as small as individual pixels but in this case the grid defines groups of pixels. These groups could be larger, as desired. The region indicated at 14 corresponds to the shadow

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cast on the screen and tone mapping in this region can be adapted to take account of this.

Figure 5 illustrates a process in accordance with the invention. At step 101, the
5 image provided by the camera 3 is analysed and at 102 an ambient luminance map is created. The difference in ambient luminance at different parts of the screen is used at 103 to create tone map modifiers.

At 104 a high dynamic range video frame is retrieved and the tone map is modified
10 at 105. The modified tone map is applied to the video frame at 106 and the tone mapped frame is displayed on the screen 2.

At 108 a check is made to see if the frame is the last in the sequence, and if it is the process ends. If it is not the last frame, the next frame is retrieved at 109 and the
15 process is repeated from step 105.

In this embodiment, the tone map modifiers remain the same for all frames in a sequence. Figure 6 illustrates a routine for altering the tone map modifiers if there is a change in ambient luminance. This takes the place of step 109 in Figure 5. At
20 201, before retrieving the next frame, the camera 3 is used to detect whether there is a change in ambient luminance and at 202 a check is made to see whether this is above a minimum threshold. If it is not, the process continues as before, If there has been a significant change in ambient luminance, an ambient luminance map is created at 203 and tone map modifiers are created at 204. The process then
25 continues as before, with the next frame being retrieved at 205, the tone map being modified at 206 and applied at 207, and the image being displayed at 208. There will then be a check for the frame being the last, and a loop back if it is not.

It will be appreciated that the check for a change in ambient luminance could be
30 made before or after a next video frame in a sequence is retrieved, and that the tone map could be modified before a frame is retrieved and then applied once it has been retrieved. A check for a change in ambient luminance could be made for each frame in a sequence, or for groups of frames, or at predetermined intervals.

Tone map modifiers could be stored in a look up table, with coordinates for pixels or
35 regions of pixels where a tone map is to be modified, and the modification that is to

be made (such as a reduction or increase in luminance above any change to be applied by the tone mapping). Tone map modification may consist of a change to a different type of tone mapping, depending on whether, for example, the display is in bright daylight or in shade.

5

Figure 7 illustrates a further refinement of the system, where user preferences are taken into account. At 301, a stream of high dynamic range (HDR) images is input, for tone mapping prior to display. These HDR images can be static individual HDR images, or a sequence of frames of HDR video footage. Any temporal information
10 related to the sequence of HDR images is extracted at 302. This can either be done dynamically as the HDR images are received, or may be from a predetermined header associated with the current sequence of HDR images. The images are then submitted to a tone map operator framework 303.

15 TMOs are typically classified as global or local. Global TMOs map the pixel values in the HDR image to the display pixel intensities based on global image characteristics, regardless of the pixel's spatial location. Local TMOs take into account the values of neighbouring pixels to the pixels being considered. Furthermore, TMOs that take into account how the content changes over time may
20 be classified additionally as temporal, for example. The parameters chosen for each TMO can significantly affect how the HDR image is displayed.

The preferred TMO and parameters are selected by the framework and used at 304 to tone map the input HDR image. The choice of preferred TMO and parameters
25 may change for every input HDR image, or remain the same for a sequence of HDR images. In addition, the choice of TMO and parameters may be influenced based on the temporal information, so as to avoid potential flickering if changes in ambient illumination (for example) occur too rapidly.

30 The tone mapped images are output at 305 and shown on the display at 306.

The framework 300 includes one or more environment sensors 307. The current environmental conditions can be determined in a number of ways, including, but not limited to: specialist environment sensing technology, for example an ambient light
35 sensor; images taken from cameras associated with the display being viewed, for

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example existing cameras on mobile devices; user centric means, for example by manual determination of the ambient light conditions; and other sensors on a device, such as accelerometers which determine orientation. In accordance with the invention, the sensor would include one or more imaging devices to capture an
5 image indicative of ambient light levels experienced at a number of positions over the display.

At 308, the framework involves knowledge of the dynamic range capabilities of the display. The dynamic range of an individual display may be defined as the
10 difference in luminance value between the brightest and darkest pixel that can be displayed.

At 309, the framework also provides for user preferences: The user, who may be either the content provider or the viewer may wish the HDR content to be watched
15 in a preferred manner, for example the mood of a certain film, or an artistic presentation style. These preferences may be encoded in data accompanying the HDR images, or may be selected by the viewer.

The framework 303 is dynamic and reactive, and determines the preferred TMO and parameters to tone map the input HDR image based on: the content of the
20 HDR image; any user preferences; any creative intent, the characteristics of the intended display; and the environmental conditions.

Figure 8 illustrates the front of a portable data processing device 15 such as a
25 mobile phone or a tablet, with a touch screen 16, a forward facing camera 17 and a control button 18. Figure 9 shows the rear of the device 15, with a rear face 19, and a rear facing camera 20. Also illustrated by dotted line is an accelerometer unit 21 which is included in the device and detects orientation. The front camera 17, rear camera 20 and optionally accelerometer unit 21 are used as described earlier to
30 provide information to the TMO framework 303. The device 15 includes a data processing module 22 which is used to set up the TMO framework.

Thus, at least in preferred embodiments of the invention there is provided method for tone mapping a high dynamic range image to be presented on a display device (15). The display device is provided camera (17) which captures an image
35 indicating ambient light levels experienced at a number of positions over the display

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(16) of the device. A data processing module (22) processes signals from the camera and generates data which is used in adapting a tone mapping function applied to the high dynamic range image so as to account for different ambient light conditions. The data processing module may take into account different lighting
5 conditions at different positions on the display when generating the data which is used in adapting the tone mapping function. The data processing module may also uses signals from a camera (20) on the other side of the device and / or from an orientation detection module (21). The data processing module may also use
10 preference data supplied with a series of video frames when adapting the tone mapping function. The device may be a mobile phone, a table computing device or a portable computer.

CLAIMS

1. A method for tone mapping a high dynamic range image to be presented on a display, wherein there is associated with the display an imaging device which captures an image indicative of ambient light levels experienced at a number of positions over the display, and a data processing module processes signals from the imaging device and generates data which is used in adapting a tone mapping function applied to the high dynamic range image so as to account for different ambient light conditions.
2. A method as claimed in claim 1, wherein the data processing module takes into account different lighting conditions at different positions on the display when generating the data which is used in adapting the tone mapping function.
3. A method as claimed in claim 1 or 2, wherein the imaging device captures images continually and the tone mapping is adapted dynamically, so that as the ambient lighting conditions change the tone mapping function changes.
4. A method as claimed in claim 1, 2 or 3, wherein the imaging device is a camera which is directed forwardly away from the display.
5. A method as claimed in claim 4, wherein the data processing module also processes signals from a second camera which is on the other side of the device from the display and is directed away from that other side of the device, and the data processing module also uses the signals from the second camera when generating the data which is used in adapting the tone mapping function.
6. A method as claimed in claim 4 or 5, wherein the device is a portable data processing device in the form of a mobile telephone, a tablet computing device or a portable computer.
7. A method as claimed in claim 6, wherein the data processing module also processes signals from an orientation detecting module of the portable data processing device and the data processing module also uses the signals from the

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orientation detecting module when generating the data which is used in adapting the tone mapping function.

5 8. A method as claimed in any preceding claim, which is used to tone map a series of image frames of a video which is displayed on the screen of the device.

10 9. A method as claimed in claim 8, wherein at least a series of the frames is provided with preference data which indicates how the series of frames is to appear, and this preference data is used by the data processing module when generating the data which is used in adapting the tone mapping function.

15 10. A data processing device which includes a display screen, a camera which is directed forwardly away from the display, and a data processing module which is configured to tone map a high dynamic range image to be presented on the display, wherein the camera captures an image indicative of ambient light levels experienced at a number of positions over the display, and the data processing module processes signals from the camera and generates data which is used in adapting a tone mapping function applied to the high dynamic range image so as to account for different ambient light conditions.

20 11. A data processing device as claimed in claim 10, wherein the data processing module takes into account different lighting conditions at different positions on the display when generating the data which is used in adapting the tone mapping function.

25 12. A method as claimed in claim 10 or 11, wherein the imaging device captures images continually and the tone mapping is adapted dynamically, so that as the ambient lighting conditions change the tone mapping function changes.

30 13. A data processing device as claimed in claim 10, 11 or 12, in the form of a mobile telephone, a tablet computing device or a portable computer.

35 14. A data processing device as claimed in claim 13, wherein a second camera is on the other side of the device from the display and is directed away from that other side of the device, and the data processing module also uses the signals from

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the second camera when generating the data which is used in adapting the tone mapping function.

15. A data processing device as claimed in claim 13 or 14, wherein an
5 orientation detecting module is provided in the portable data processing device and the data processing module also uses the signals from the orientation detecting module when generating the data which is used in adapting the tone mapping function.
- 10 16. A data processing device as claimed in any of claims 10 to 15, wherein the data processing module is adapted to use preference data when generating the data which is used in adapting the tone mapping function, the preference data being provided for a series of image frames of a video and indicating how the series of frames is to appear.

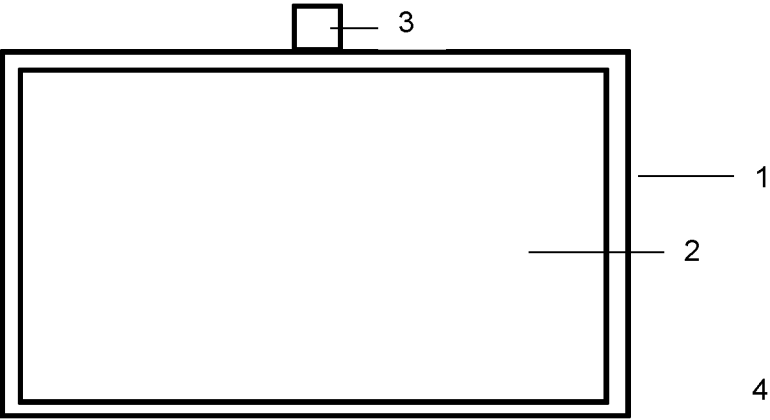


Figure 1

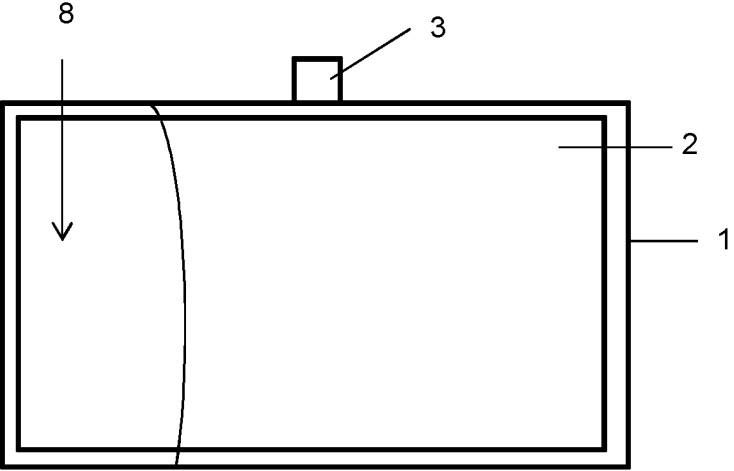
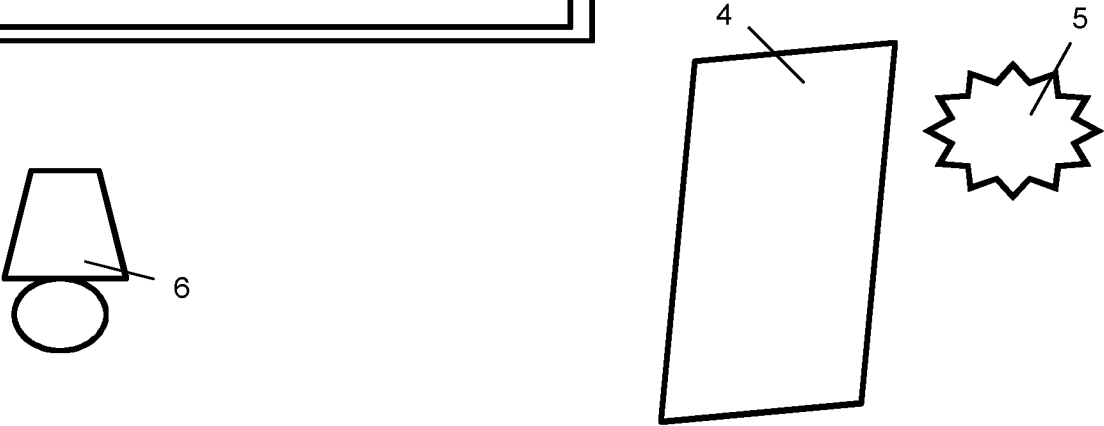
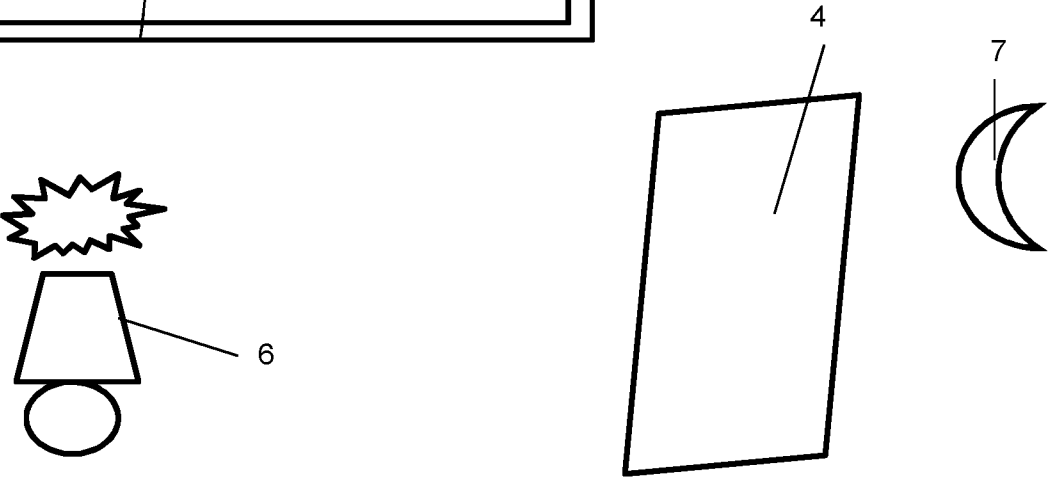


Figure 2



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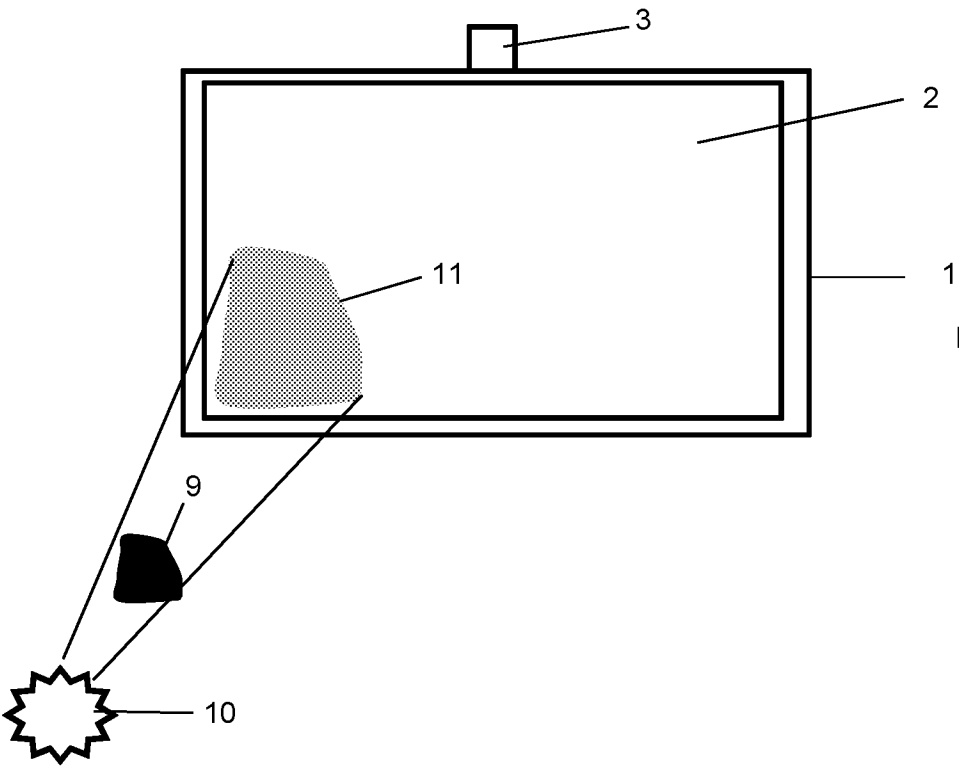


Figure 3

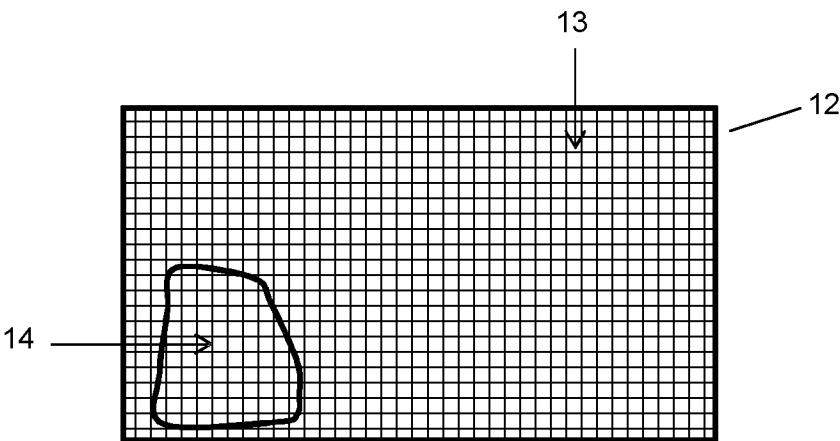


Figure 4

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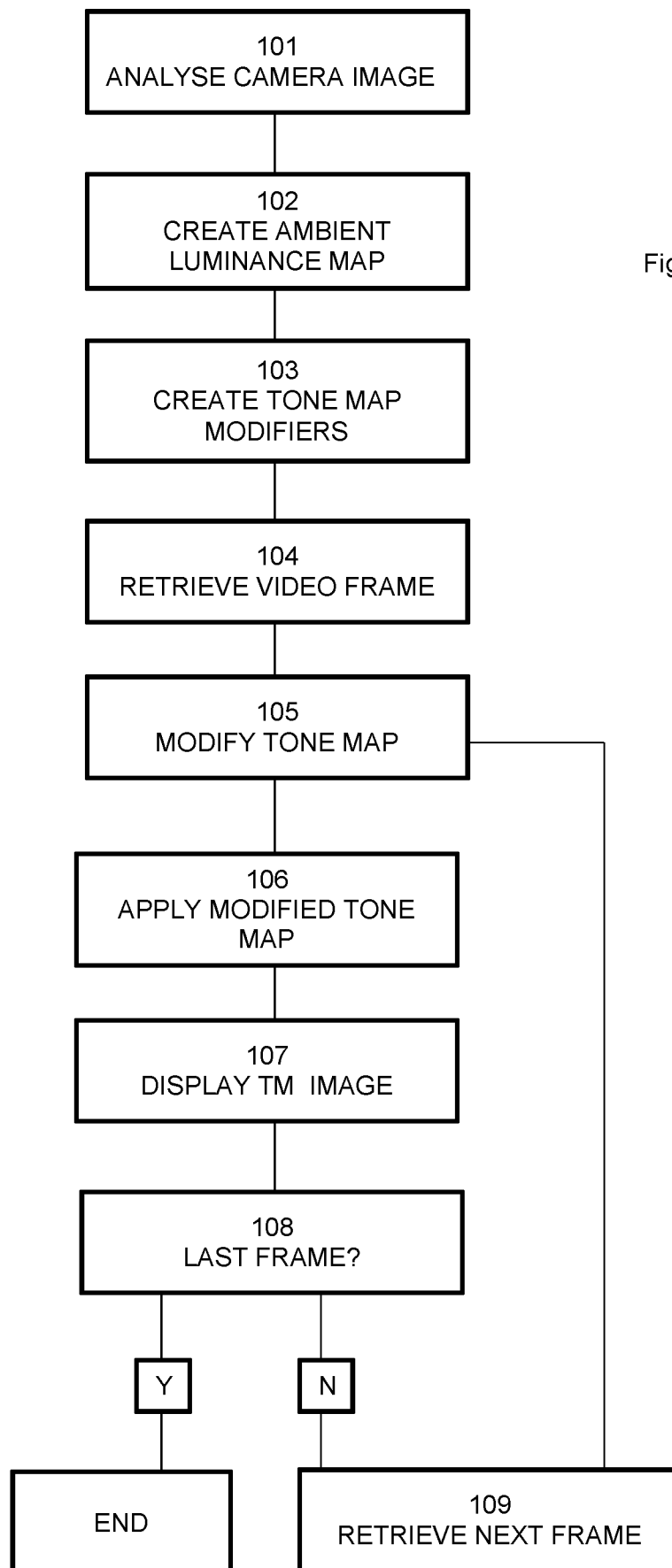


Figure 5

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Figure 6

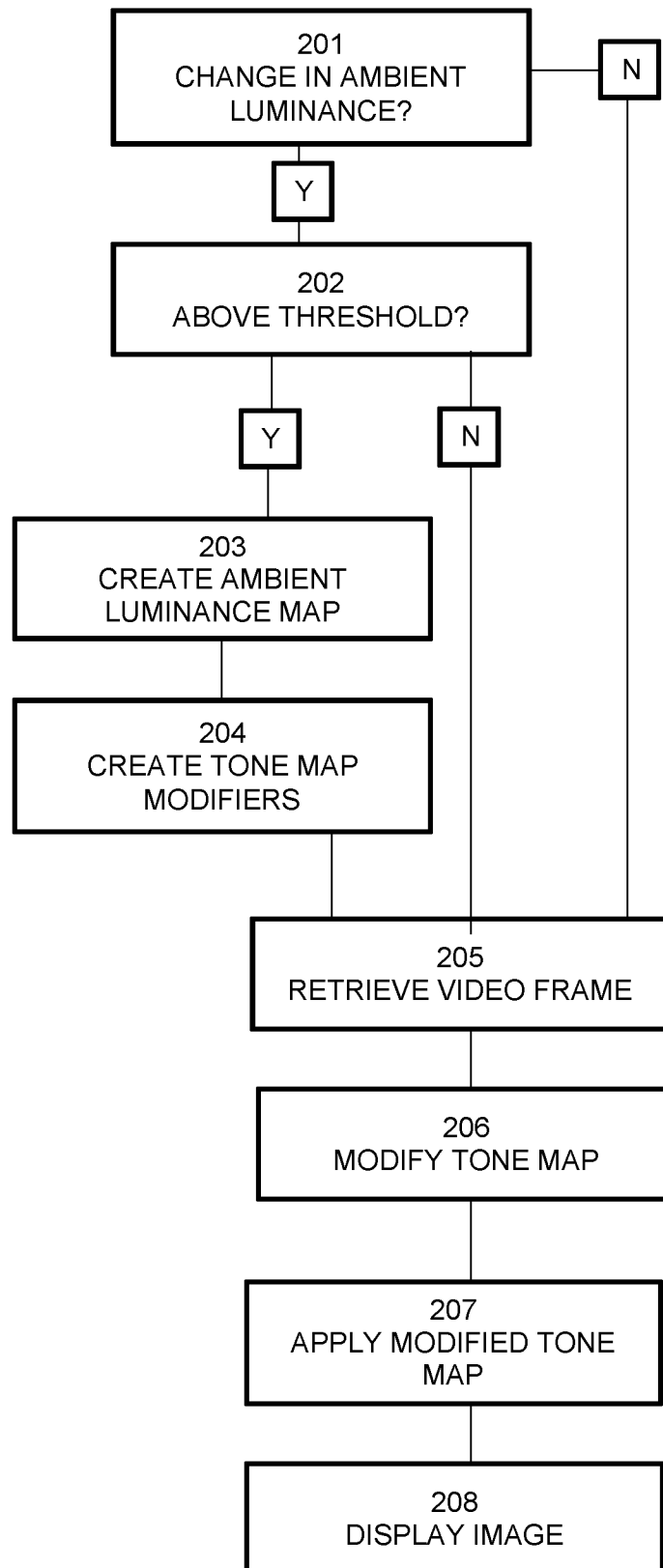
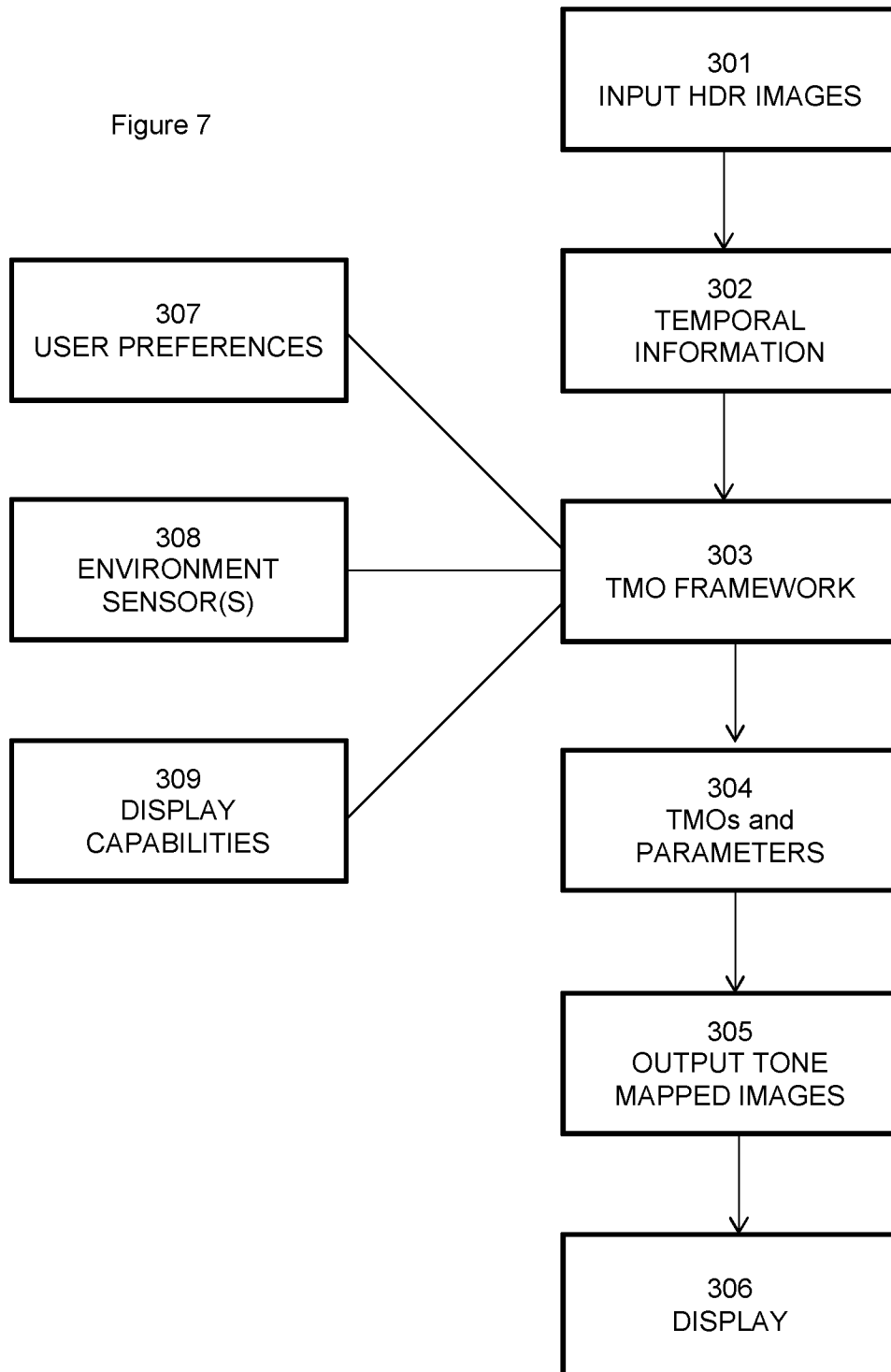


Figure 7



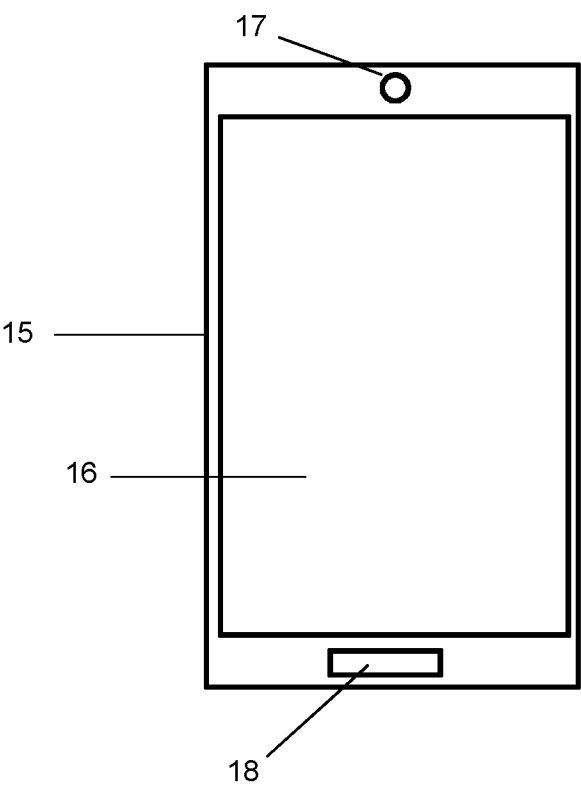


Figure 8

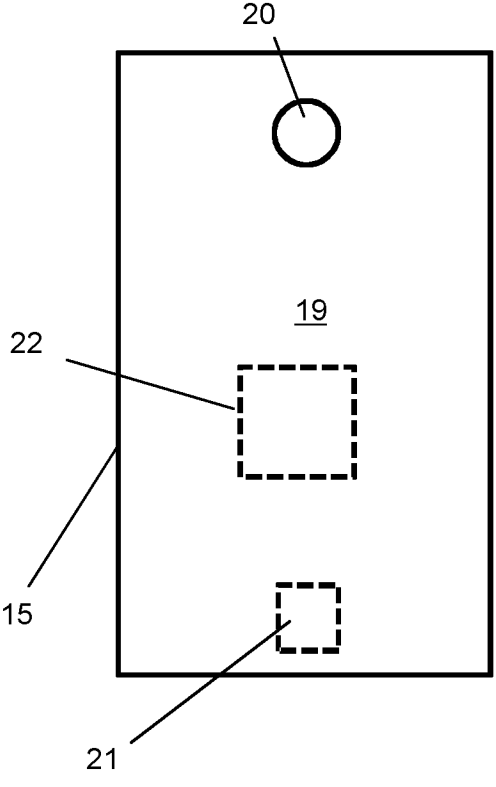


Figure 9

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2014/050696

A. CLASSIFICATION OF SUBJECT MATTER

INV. G06T5/00

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)

G06T

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 practicable, search terms used)

EPO-Internal, WPI Data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MANTIUK ET AL: "Display adaptive tone mapping", ACM SIGGRAPH 2008 PAPERS ON, SIGGRAPH '08, 1 January 2008 (2008-01-01), page 1, XP055043632, New York, New York, USA DOI: 10.1145/1399504.1360667 ISBN: 978-1-45-030112-1 cited in the application abstract Section 5 Section 6.1 Section 7 figure 1 ----- -/-	1-16



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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"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

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"&" document member of the same patent family

Date of the actual completion of the international search

22 May 2014

Date of mailing of the international search report

03/06/2014

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Salvador, Elena

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2014/050696

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 2011/097060 A2 (MICROSOFT CORP [US]) 11 August 2011 (2011-08-11) abstract paragraph [0020] - paragraph [0021] paragraph [0134] - paragraph [0140] figure 10 -----	9,16
A	WO 2012/030622 A1 (DOLBY LAB LICENSING CORP [US]; NINAN AJIT [US]; JIA WENHUI [US]) 8 March 2012 (2012-03-08) abstract paragraph [0018] paragraph [0035] -----	1-16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2014/050696

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