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(54) **Device and method for compensating the degradation of the light output of a plasma display panel**

(57) A device for compensating a degradation of a light output of a cell of a plasma display which occurs during the operation of the plasma display. The device for compensating comprises means for providing and storing data concerning brightness and duration of said brightness of at least one cell of the plasma display over a specified time period. Furthermore the device for compensating comprises means for providing a compensation value for the at least one cell of the plasma display for compensating the degradation of the light output of the at least one cell based on the stored data of the at least one cell to ensure that the brightness of the cell corresponds approximately to a brightness of a cell with a non-degraded light output. In accordance with the present invention there is provided a device and a method that increases the operating lifetime of a plasma display and reduces the occurrence of the burn-in effects in an flexible way.

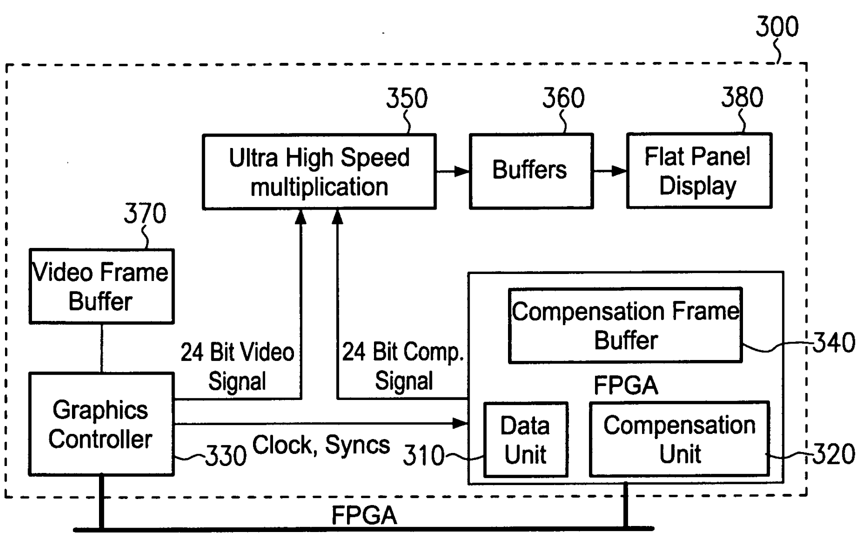

Fig. 3

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention generally relates to computer displays and public displays, and in particular to a device and method for compensating the degradation of a light output of a plasma display panel.

2. Description of the Related Art

[0002] Displays are an important but expensive part of the interface between man and machine. Therefore, one of the most significant expressions of the digital age are the omnipresent displays showing data, information and pictures. These displays are used for wrist watches, calculators and laptops but also more and more as public displays. This new generation of flat panel displays can be found at many places like presentation rooms, show rooms, mini theatres and in the public. They are used at work or at school for video conferencing or presentations, in public or company facilities as information displays or at airports, train and bus stations for departure and arrival information. Many other applications emerge now as the displays become more reliable and stable in quality.

[0003] All modern displays are based on a conversion of electrical signals in optical signals. For a business application the electro-optical properties for display have to fit to the application conditions. According to their physical properties displays are divided into active and passive displays. Active displays, e.g. cathode ray tube, light emitting diode displays, vacuum fluorescence displays and plasma displays are emitting light to create the image. Passive displays, e.g., liquid crystal displays do not create the emitted light but use the ambient light.

[0004] Active displays use phosphors for generating visible light, either by exiting with electrones (CRT, VFD, FED), or UV light (plasma display) or fast charged carriers (electro luminescence display).

[0005] As shown in FIG. 1 colored plasma display panels have a simple construction, basically consisting of two thin sheets of glass separated by a few hundred microns, the front glass substrate 110 and the rear glass substrate 120. The space between the sheets of glass is filled with cells 130 containing a rare gas (xenon, neon etc.). Each cell is coated on the bottom and at the surface of the barrier rib 140 with a different color of phosphor in red, green or blue. Electrodes (150, 160 and 170) can be found at the top and bottom of each sheet of glass or substrate. In ordinary fluorescent slides, voltage is supplied to the electrodes, resulting in an electrical discharge 180. This creates an ultraviolet emission, which emits fluorescent materials that coat the inside of the bulb.

[0006] In the color plasma display panel (PDP) voltage is supplied to selected cells depending on the image and the red, green and blue phosphor combine to create the colors in the images displayed. As shown in FIG. 2 therefore three cells, one red, one green and one blue are combined to form one pixel.

[0007] Referring back to FIG. 1 to create the red, green or blue light in the cells first a voltage is supplied to the scan electrode 170 and the sustain electrode 160, effecting a preparatory, or "priming" electrical discharge. Then voltage is supplied to the scan electrode 170 and the data electrode 150 of the cell to which data is to be written, resulting in a discharge. This in turn creates a wall charge on the dielectric layer of the addressed cell. In a third step, voltage is applied again to the scan electrode 170 and the sustain electrode 160, generating a discharge which is emitting ultraviolet rays. If an AC voltage is continuously applied, the process occurs repeatedly, resulting in the emission of light for displaying an image. Finally, in order to neutralize the wall charge in the cell in preparation for the next screen update, a lower voltage is supplied to the scan electrode and the sustain electrode, resulting in a low level discharge.

[0008] One important aspect for public or information displays is the size as especially large color displays are ideally suited for information display systems in airports, railway stations and convention centers. The currently available 42 inches to 61 inches color plasma displays combine the advantage of low depth and weight with a viewing angle of more than 160°. Although CRT and TFT may be used as public displays, presently, the only flat display technology for business applications with a large diagonal measurement is the plasma technology. Its basic principle uses the plasma effect for light generation as described above.

[0009] In general, an information display is a display device with an integrated PC. The controller may be a computer with network and graphics abilities. An embedded display controller allows the integration into already existing FIDS networks. Special versions with integrated PC are already available. They are offering an integrated PC platform based on an Intel Pentium 3 processor. Additionally several free PCI or ISA slots allow the integration of network or ISDN cards, hardware MPEG 2 decoders and any other cards that are suited for the application. Furthermore, these modern displays include a processor, a Random Access Memory, a graphic card or a graphic controller, interfaces like RS232, RS485, USP or parallel interfaces and interfaces for mouse and keyboards, hard disks or other system components. Furthermore, they include a power supply, climate control circuit, a TV cable tuner, audio amplifiers and integrate loud speakers or have interfaces for external loudspeakers.

[0010] In this way, such a high performance PC platform provides all necessary functions for state of the art advertising or multimedia presentations including live video sequences and high resolution graphics. All PC based operating systems and application programs can be implemented and make the unit into an intelligent display terminal.

[0011] There are also offered information displays based on a controller system. The controller system includes an integrated graphic engine board which provides not only the local intelligence but also the control of key display functions from a central server in the network. The graphic engine board controls the picture performance to minimize a jitter or a phase or scaling error. A gamma correction circuitry ensures true color display of graphics or videos. An integrated hardware watchdog monitors the controller function and automatically reboots the unit in case of system shutdown or fault. The optional hardware MPEG 2 video audio decoder allows programmable propping and positioning of full motion video and graphics overlay.

[0012] The embedded controller types provide a signal and a control interface to the specific display subsystem used. The created pages are saved in a video memory. It is read out with the pixel clock and transferred to the display. The control interface can be an I^2C or a control bit interface. The displayed image on the screen can be seen as a copy of the video memory content.

[0013] The contrast control function on an embedded controller is realized inside the graphics controller chip. Contrast control varies the end level of the gamma correction color look-up table.

[0014] On internal direct digital links between the video memory output and the display module input the video memory is organized with the physical resolution of the connected display. The range of resolutions range from VGA to UXGA or 16:9 formats like the popular WVGA with 848 X 480 picture elements. FIG. 2 shows schematically such a display. Another resolution method is ALIS (alternate lighting of surfaces method) that alternately displays odd and even lines at high speeds. This technology makes it possible to create high resolution images using about the same number of electrodes as used in conventional VGA technology. ALIS technology provides a pixel resolution of 1024 X1024 compared with WXGA displays providing 768 X 1365 .

[0015] Furthermore, an optional touch screen system offers an excellent large screen man-machine interface for any point of information application. All these terminals are built for 24 hour operation in professional applications and uses high grade industrial components.

[0016] Due to their network capabilities a system integrator can configure the displays according to special requirements. In most of the applications the information displays are connected as remote displays with a network connection to a server. The operating system of the application's specific software installed on the embedded controller, communicates with the server and builds pages with the commands coming via the network. Specific software allows the complete control of most of the display alignment and control functions.

[0017] Their technology makes the color plasma displays immune against magnetic interference and hence suitable for installation near railways, industrial applications with high electric energy and even for mobile use without the need of additional shielding. The normal linearity, geometry, conversion and focussing problems well known to users of conventional CRTs monitors simply do not exist, there is a uniform clarity to the digital operation of the color plasma displays where each cell is addressed individually.

[0018] The color depth of video memories varies depending on quality requirements and displayable numbers of colors between 4 and 10 bits per primary color red (R), green (G) and blue (B). For example, 8 bits per color is equivalent to 256 shades of each color resulting in 16.7 million colors.

[0019] The contrast control of a display varies the gain of the video input signal. It can vary from 0% to 100%. The full set of contrast control uses the maximum dynamic range of the connected display.

[0020] As mentioned above, the walls of the cells are coated with phosphors for converting the UV rays invisible light. On the one hand phosphors must have a high quantum efficiency, that means that the absorbed UV light is transformed in maximum possible amount of visible light. And on the other hand, the phosphors may not luminescence longer than 10 milliseconds, otherwise a picture refresh rate of 100 Hz would be influenced by the luminescence. As mentioned above, the cells are filled with rare gases or a mixture of rare gases where generally a mixture of neon and xenon with a 3 to 5% ratio of xenon is used. This neon xenon plasma emits radiation in the range of 140 to 190 nm. As suitable phosphors for PDPs are used $Y(V,P)O_4$:Eu or (Y,Gd) BO_3:Eu for red color, Zn_2SiO_4:Mn for the color green and $BaMgAl_{10}O_{17}$:Eu for the color blue. The blue phosphor $BaMgAl_{10}O_{17}$:Eu has a lower stability under VUV light as the red and green phosphors. Therefore, during the operation time the blue colors of the plasma display will fade out and the original white of the display will shift to a yellow. This degradation of the blue phosphor is caused by oxidation of the activators Eu^{2+} to Eu^{3+}. The use of different phosphors may improve the stability but on the other hand the luminescence will be prolonged, which influences the refresh rate of the display.

[0021] The phosphor elements in a plasma display do not radiate their colored light at a constant amplitude during their life span. The intensity degrade is high during the first few of hours. After that period of time the curve is more horizontal, but still lowering during the course of the remainder of its lifetime. Due to the rapid changes in brightness at the very beginning it is necessary to let the display undergo "pre-burn-in" period. This is usually a couple of days the usual lifetime of a commercial plasma display is about 10 000 hours. After that period the brightness of the display will be much lower and, in the case of static images, certain areas will be less or more bright. These are so-called "burned-in-mark areas".

[0022] Therefore it is necessary to develop a special PDP driving mechanism to increase the operating lifetime and reduce occurrence of so-called burn-in affects. As mentioned above, PDPs are based on phosphors like cathode ray tube base monitors. Red, green and blue phosphors are exited by UV light to generate colored light. The light output of the phosphors degrades over time resulting in lower brightness over the lifetime of the product. For moving pictures and typical video sequences, all colors and all areas of the screen are stressed and worn out evenly so it is almost impossible to notice the reduction in brightness. In airport applications however, where the image displayed is often static (e.g. airline logo) the screen is not stressed equally. This leads to an uneven brightness degradation, which results in the burn-in of the image on the screen. For example, if a blue circle is displayed continuously in the center of the screen, only the blue phosphor would be worn out in this area. If after some time it tries to display a full white picture, the area of the blue circle would appear quite yellow. This is because the red and green, which are not worn at all, will make a greater contribution than that of the worn out blue with the result been yellowish. This phenomenon is well known and can of course be reduced by careful use of the display and using simple tricks such as screen savers, inverse colors and moving the images where possible. However, a lot of applications do not allow temporary removal of the usable information or to change the standard colors of a logo.

[0023] Another way of burn-in reduction is an orbiter function that slowly, but imperceptibly, moves the image over a number of pixels. This amount of pixels must be small (smaller than 10 pixels) to maintain as much usable display area as possible. As a consequence, this system will not be effective when large areas of the display (e.g., big airline logo) are being used. It will only result in smoother transitions from the burned-in area to the non burned-in area.

[0024] Moreover, the intensity degrade is high during the first 10^{th} of hours. After that period of time, the curve is more horizontal, but still lowering during the course of the remainder of its lifetime. Due to the rapid changes in brightness at the very beginning it is necessary to let the display undergo a "pre-burn-in" period. This is usually a couple of days.

[0025] The useful lifetime of a commercial plasma display is about 10 000 hours. After that period the brightness of the display will be much lower and, in the case of static images, certain areas will be less or more bright.

[0026] US 5821917 discloses a system and method to compensate for the effects of aging of the phosphors and faceplate upon color accuracy in a cathode ray tube wherein beam current measurements are made upon individual cathodes of a cathode ray tube to sample the individual beam currents at periodic intervals. The sum totals of the individual beam current measurements are then stored in a non-volatile memory and correction factors are calculated for both luminous efficiency degradation and deviations in hue, based on the stored sum total beam current measurement.

[0027] Due to rationalization and the need for information there is a big demand for public displays providing the necessary quality in color stability and offering the possibilities for a flexible administration. Moreover, due to this claimed flexibility there is a need to reduce the occurrence of burn-in effects in a way that also allows the multifunctional use of these displays.

SUMMARY OF THE INVENTION

[0028] An improved device and method for compensating a degradation of a light output of a cell of a plasma display panel which occurs during the operation of the plasma display, is provided that may allow to compensate the effects of aging of the phosphors upon color accuracy in plasma display panels.

[0029] In one embodiment, a device for compensating a degradation of a light output of a cell of a plasma display which occurs during the operation of the plasma display is provided. The device comprises means for providing and storing data concerning brightness and duration of that brightness of at least one cell of the plasma display over a specified time period. Furthermore, the device comprises means for providing a compensation value for the at least one cell of the plasma display for compensating the degradation of the light output of the at least one cell based on the stored data of the at least one cell to ensure that the brightness of the cell corresponds approximately to a brightness of a cell with a non-degraded light output.

[0030] In a preferred embodiment, a device for compensating a degradation of a light output of a cell of a plasma display which occurs during the operation of the plasma display is provided. The device comprises means for providing and storing data concerning brightness and duration of that brightness of cells of the plasma display over a specified time period. Furthermore, the device comprises means for providing a compensation value for the cells of the plasma display for compensating the degradation of the light output of the cells based on the stored data of the cells to ensure that the brightness of the cell corresponds approximately to a brightness of cells with a non-degraded light output. The device further comprises a graphics controller adapted for generating a video signal for displaying pictures on the plasma display and wherein the means for providing a compensation value further comprises a programmable signal processing device comprising a compensation frame buffer for storing the compensation value for the at least one cell of the plasma display. The means for providing a compensation value further comprises a high speed multiplication unit for correcting video signals using the compensation value of the at least one cell and a buffer for storing the results of the high speed multiplication. The high speed multiplication unit is connected to the graphics controller for receiving video signals generated by the graphics controller and to the programmable signal processing device for receiving the compensation values. Furthermore, the means for providing and storing data are providing and storing data for each single cell of the plasma display. Additionally, the programmable signal processing device provides compensation values for each single cell of the plasma display based on the stored data of each single cell regarding the degradation of different phosphors used in the different cell types and stores the compensation values for each single cell in the compensation frame buffer at every refresh cycle the plasma displays operated with. Initial values for the compensation values of the cells are stored in the compensation frame buffer so that an initial maximum adjustable brightness of the cells is limited to a specific percentage of a maximum allowable brightness of the cells. Additionally, the programmable signal processing device further comprises a configuration unit with an interface for inputting data for changing the compensation value of the at least one cell in the compensation frame buffer.

[0031] In second preferred embodiment, a device for compensating a degradation of a light output of a cell of a plasma display which occurs during the operation of the plasma display is provided. The device comprises means for providing and storing data concerning brightness and duration of that brightness of at least one cell of the plasma display over a specified time period. Furthermore, the device comprises means for providing a compensation value for the cells of the plasma display for compensating the degradation of the light output of the cells based on the stored data of the cells to ensure that the brightness of the cells corresponds approximately to a brightness of cells with a non-degraded light output. The device for compensating a degradation of a light output further comprises a graphics controller adapted for generating a video signal for displaying pictures on the plasma display and wherein the means for providing a compensation value further comprises a programmable signal processing device with a compensation frame buffer for storing the compensation values for the cells of the plasma display. The programmable signal processing device is connected to the graphics controller for receiving the video signals and is correcting the video signals using the compensation values of the cells. The compensation frame buffer is a Flash Memory, a Random Access Memory or a Hard Disk. The device for compensating a degradation of the light output includes the interface which is connected to the programmable signal processing device and the programmable signal processing device is configurable while the interface over a computer network or a telecommunication network. Additionally, the programmable signal processing device further comprises a configuration unit with an interface for inputting data for changing the compensation value of the at least one cell in the compensation frame buffer. The programmable signal processing device provides compensation values for each single cell of the plasma display based on the stored data regarding the degradation of different phosphors used in different cell types and stores the compensation values for each single cell in the compensation frame buffer. The means for providing and storing data providing and storing data for each single cell of the plasma detail. Furthermore, the means for providing and storing data are providing and storing data at every refresh cycle the plasma display is operated with. Additionally the programmable signal processing device provides compensation values at every refresh cycle the plasma display is operated with.

[0032] In a third preferred embodiment there is provided a calibration system for calibrating a compensation value for the cells of the plasma display to compensate the degradation of the light output of the cells, which comprises the device for compensating a degradation of a light output according to the first and second embodiment. The calibration system further comprises an electronic camera for taking screen images of the plasma display for measuring brightness of at least one cell of the plasma display and a PC or a laptop connected to the electronic camera and the configuration unit of the device for compensating a degradation of a light output. The programmable signal processing device further comprises the configuration unit with an interface for inputting data for changing the compensation value of the at least one cell of the compensation frame buffer. The electronic camera is transmitting data of the taken screen images to the electronic device. The electronic device is transforming the transmitted data to the compensation values for the at least one cell of the plasma display and is transmitting the compensation values to the configuration unit to change the compensation value of the at least one cell in the compensation frame buffer.

[0033] Furthermore, another embodiment is provided a method for compensating a degradation of a light output of a cell of a plasma display which occurs during the operation of the plasma display, comprising the steps of providing and storing data concerning brightness and duration of that brightness of at least one cell of the plasma display over a specified time period and providing a compensation value for the at least one cell of the plasma display for compensating the degradation of the light output of the at least one cell based on the stored data of the at least one cell to ensure that the brightness of the cell corresponds approximately to a brightness of a cell with a non-degraded light output.

[0034] In accordance with the present invention there is provided a device and a method that increases the operating lifetime of a plasma display and reduces the occurrence of the burn-in effects in an flexible way. It is suitable for both kinds of displays either showing static or dynamic pictures. The device and method is usable for different kinds of displays as it is configurable and offers to be administrated via computer network. Furthermore, it offers the advantage that it can be integrated in already existing displays. Using the calibration system in accordance with the present invention a time and cost saving device and method is offered for adjusting the brightness of each cell of a display whenever it is need.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The accompanying drawings are incorporated into and form a part of the specification for the purpose of explaining the principles of the invention. The drawings are not to be construed as limiting the invention to only the illustrated and described examples of how the invention can be made and used. Further features and advantages will become apparent from the following and more particular description of the invention, as illustrated in the accompanying drawings, wherein:

FIG. 1 is showing a schematical diagram illustrating the structure of a cell of a plasma display;

FIG. 2 is showing a schematical diagram illustrating the set-up of a plasma display;

FIG. 3 is showing a schematical diagram of a first preferred embodiment of the present invention;

FIG. 4 is showing a diagram displaying the brightness over time of plasma displays without a device for compensating a degradation of a light output of the cells of the plasma display comparing with plasma displays including a preferred embodiment of the present invention.

FIG. 5 is showing a schematical diagram illustrating the application of another preferred embodiment of the present invention;

FIG. 6 is showing a schematical diagram illustrating a preferred embodiment of the calibration system in accordance with the present invention;

FIG. 7 is showing another schematical diagram illustrating a preferred embodiment of the calibration system in accordance with the present invention;

DETAILED DESCRIPTION OF THE INVENTION

[0036] The illustrative embodiment of the present invention will be described within reference to the figure drawings.

[0037] FIG. 3 illustrates in a schematical diagram the device for compensating a degradation of a light output of a cell for plasma display according to a first preferred embodiment of the present invention. The compensating device has a unit 310 for providing and storing data concerning brightness and duration of the brightness of cells of a plasma display. The unit 310 for providing and storing data is capable of providing the brightness and duration data in accordance to a specific time period. For this the unit collects data for each cell of the plasma display how long and how intensively the cell was activated. The data unit 310 is connected to a compensation unit 320, which is providing a compensation value for the cells of the plasma display.

[0038] The compensation unit 320 is providing compensation values for compensating the degradation of the light output of the cells of the plasma display based on the stored data of the cells to ensure that the brightness of the cell corresponds approximately to a brightness of a cell of the plasma display with a non-degraded light output. Preferably, the compensation unit 320 comprises a programmable signal processing device with a compensation frame buffer 340 for storing the compensation values. Furthermore, the compensating device 300 includes a graphic controller which is generating video signals for displaying pictures on a display preferably on a plasma display. Additionally, the compensating device 300 includes a high speed multiplication unit 350 for correcting video signals using the compensation value provided by the compensation unit 320. For this the high speed multiplication unit 350 is connected to the graphics controller and to the compensation unit 320. Results of the high speed multiplication are transmitted to a buffer 360 for providing the compensated video signals to a display preferably plasma display. For synchronizing the video signals generated in the graphics controller and compensation values provided by the compensation unit 320 the data unit 310 and unit compensation 320 are connected to the graphics controller for synchronizing the processing cycles. For receiving digital signals of pictures to be displayed on the display the graphics controller 330 and the data unit 310 and the compensation unit 320 have an interface to be connected to a computer bus system or a computer network or a telecommunication network. Preferably, these units comprise a PCI slave interface.

[0039] As shown in FIG. 3 in an alternative of the preferred embodiment of the present invention the data unit 310 and the compensation unit 320 are integrated in a field programmable gate array (FPGA). This is a programmable hardware block which includes also the PCI slave interface and additional registers for horizontal and vertical resolution programming. It further comprises a glue logic for reading and writing the compensation values in the compensation frame buffer 340. The read out of the compensation values of the compensation buffer and the serialization of the compensation values is synchronized with a high speed pixel clock also included in the FPGA. The high speed clock is synchronized with the clock of the graphics controller. Preferably the FPGA circuit is clocked with 100 MHz. Alternatively, the clock is operated with a lower or higher frequency in accordance with the application.

[0040] For the design of the FPGA circuit the color resolution, the display resolution and the refresh rate of the display has to be considered.

[0041] For a preferred high speed alternative all components like graphics controller, video frame buffer, data unit, compensation unit, compensation frame buffer, high speed multiplication unit and buffers for the compensated video signal for the display panel etc. are integrated on one printed circuit board (PCB). As output devices for outputting the compensated video signal are preferably used LVTTL or LVDS devices. This increases the performance of the compensating device 300 and reduces the number of piece parts.

[0042] Alternatively, the programmable signal processing device on the FPGA or the FPGA itself comprises a serial or parallel interface or an interface to a computer network or telecommunication network. Preferably the FPGA includes a RS232 or a USB and an Ethernet interface. Via these interfaces the FPGA or the programmable signal processing device is configured or updated. This interface is used to select specific operation modes of the programmable signal processing device and the FPGA functions. Via these interfaces it is possible to adjust the clock frequency in accordance with the application and to store or update programs in a memory of the FPGA.

[0043] Therefore it is possible to configure the programmable signal processing device in accordance with the application either that it determines compensation values of the cells of the display using a look-up table or calculating the compensation values using a specific formula. This specific formula is changeable in accordance with the display which is operated by the compensating device 300.

[0044] Furthermore, the programmable signal processing device is either configurable that only cells of a specific area of the displays are compensated or that all cells of the displays are compensated. Furthermore, the three different cell types (red, green and blue or cyan, magenta and yellow), forming one pixel are compensated regarding the degradation of the different phosphors used in the different cell types.

[0045] Moreover, the time cycles for providing and storing the data concerning brightness and duration of the brightness are adjustable to a specific time period and also the time cycle for providing the compensation values for all cells or only for a part of the cells of the display. It is also possible to adjust the time cycle for providing and storing the data and providing the compensation values to the refresh cycle of the display, e. g. 100 Hz.

[0046] Via the above-mentioned network interface or an additional configuration interface the compensation values in the compensation frame buffer are thereby changeable. It is configurable whether all compensation values in the compensation frame buffer are changed or only a specific compensation value in the compensation frame buffer.

[0047] In accordance with a preferred embodiment of the present invention the initial value for the compensation values in the compensation frame buffer are defined so that an initial maximum adjustable brightness of the cells is limited to a specific percentage of a maximum allowable brightness of the cells. Preferably, this compensation value is set to a value that the initial maximum brightness of the cells is 80% of a maximum allowable brightness of the cells. This might be seen as a commercial disadvantage, but it will certainly drastically lengthen the display's lifetime not only concerning the color quality. The remaining 20% can be used to compensate the degradation in brightness on a cell per cell or pixel or pixel basis. Without this margin a compensation of the degradation of the brightness is not possible.

[0048] As mentioned above the data unit 310 or alternatively the FPGA is continuously gathering information of the RGB brightness and the duration of the brightness of every cell or every pixel formed by the three different cell types. That information is stored in a memory included in the FPGA. A formula will calculate a compensation value for each RGB cell of each pixel and hold this in the compensation frame buffer. Alternatively the compensation values for each RGB cell of each pixel are provided by a look-up table. Before an update of the image or part of the image is done the video signal will be multiplied by the compensation values in the high speed multiplication unit 350 for each pixel. The high speed multiplication unit is capable to do this for a 24 bit or higher video mode. Furthermore the preferred embodiment is capable of compensating MPEG video for digitized analogue video coming from a real time analogue source.

[0049] As mentioned above, in the case that a blue circle is displayed continuously in the center of a screen, only the blue phosphor would be worn out in this area. One tries to display a full white picture and after some time the area of the blue circle would appear quite yellow without compensating the degradation of the light output of the blue cells. This is because the red and green cells which are not as worn out at all, will make a greater contribution to the brightness than the worn out blue. The result is a yellowish color instead of a white color.

[0050] Using the preferred embodiment of the present invention all blue cells previously showing that circle will be compensated with a slightly higher brightness value. Therefore it is possible to prevent a yellowish circle in the white picture. This compensation procedure is done as long as there is a margin in the brightness value that can be programmed. Once 100% of the brightness signal is reached the cells are addressed with, the degradation of the brightness will start to become visible. Therefore the preferred embodiment of the present invention lengthens the lifetime of displays by displaying a perfect picture for a much longer period than in a non-compensated display.

[0051] As already mentioned in the preferred embodiment, the data unit 310 is collecting the data concerning the brightness and the duration of the brightness for specified cells within a specific time period. The data is either accumulated by the data unit and then provided to the compensation unit 320 or provided to the compensation unit 320 without accumulating. For the second alternative the compensation unit is accumulating the data and alternatively storing the history of the data.

[0052] In a second preferred embodiment there is provided a device for compensating a degradation of a light output of cells of a plasma display, which comprises a data unit 310 for providing and storing data concerning brightness and duration of the brightness of cells of a plasma display and a compensation unit 320 for providing a compensation value for cells of a plasma display for compensating the degradation of the light output of the cells based on the stored data of the cells. The compensating device 300 further comprises a graphics controller, which is generating video signals for displaying pictures on a display. The compensation unit 320 for providing compensation values further comprises a programmable signal processing device with a compensation frame buffer 340 for storing the compensation values. The signal processing device is either connected to the graphics controller for receiving signal or a computer bus system to correct the video signals of the graphics controller using the compensation values of the cells stored in the compensation frame buffer. The data concerning the brightness and the duration of the brightness of the cells is preferably stored in a Flash Memory, Random Access Memory or on a Hard Drive. The programmable signal processing device calculates the compensation values for cells either of a specific part of the display or the whole display. This can be done by a specific formula or compensation values are provided by using a look-up table. After calculation of the compensation values of a part of the cells or all cells of a display the compensation values will be stored in the compensation frame buffer 340. But preferably the compensation values for all cells are calculated and updated for every refresh cycle.

[0053] Preferably the graphics controller and the programmable signal processing device have an interface to a computer bus system, a computer or a telecommunication network or/and a serial and parallel interface. Alternatively the graphics controller, the programmable signal processing device, the compensation frame buffer and an additional video frame buffer for the graphics controller are arranged on one PCB. In a preferred alternative the PCB further includes processor like Pentium 3, Random Access Memory, Serial RS232, Interface, Parallel Interface and an Interface for a mouse and a keyboard and a USB interface. Furthermore, this preferred alternative provides a hard disk and an Ethernet interface and is capable of running an operations system. Furthermore it provides a power supply for the electronic components. FIG. 6 shows in a schematic diagram also a block diagram of a preferred alternative 610 of this embodiment, with the integrated components like additional climate control etc.

[0054] In the preferred alternative the calculation of the compensation values of the cells of the display is done by a software module which is executed by the processor in combination with the Random Access Memory and the Hard Disk. It continuously gathers information of the brightness and the duration of the brightness of every cell or pixel, which is built by the three different cell types. Before an update of the image or a part of the image is done, the compensation software will correct the RGB values of the video signal with the compensation values for each cell respective pixel. Furthermore, the second preferred embodiment of the present invention includes a configuration unit with an interface for inputting data for changing the compensation values in the compensation frame buffer. This ensures that initial compensation values can be manually or automatically configured in accordance with a specific application or a specific display type.

[0055] By storing and accumulating the data for the intensity and the duration of the brightness of each cell separately this data can be reused for calculating an improved set of compensation values in the case that an improved formula or improved look-up table is provided for calculating the compensation values.

[0056] Preferably an initial value for the compensation values is stored in the compensation frame buffer, so that an initial maximum adjustable brightness of the cells is limited to a specific percentage of a maximum allowable brightness of the cells. The remaining margin can be used to compensate the degradation of the brightness of the display on a pixel per pixel basis. Alternatively different formulas or a look-up table are used for calculating the compensation values of the different cell types (red, green and blue or cyan magenta and yellow). As mentioned above, also this preferred embodiment is configurable so that the degradation of the brightness of cells of a part of the display or of the whole display is compensated. Furthermore, it is adjustable via the computer network interface in which time period the data concerning brightness and duration of the brightness are stored and in which time period the compensation values for the cells are calculated and updated in the compensation frame buffer. Preferably this is done with every refresh rate of the display, e.g. 100 Hz.

[0057] FIG. 4 illustrates a degradation of brightness of two different information displays compared with the information displays using a preferred embodiment of the present invention. As it can be seen from the illustration, the brightness level of the display using e.g. ALIS technology or WVGA technology degrades with time. Although the uncompensated screens show a higher brightness during the beginning of their operation time the compensated displays offer a constant brightness level of the cells over a long operation time of several thousand hours. This is necessary for offering an adequate color quality.

[0058] FIG. 5 illustrates an alternative of the first and second preferred embodiment in a schematic diagram, wherein the compensating device 300 is a stand alone device which is addressed, configured and programmed via a computer network or a telecommunication network. For this the compensating device 300 includes an interface to be connected to a computer network or to a wireless telecommunication network or an ISDN- or a DSL interface.

[0059] Furthermore, the compensating devices 300 are connected to plasma monitors 550, CRTs 560 or LCDs 570 and are configured according to the application via the network 520 with a computer 510 also connected to the computer network or to a telecommunication network. The pictures to be displayed on the plasma display, CRT or LCD are either provided by the computer 510, which is configuring the compensating device or other computers (530, 540) connected to the computer or telecommunication network which are allowed to address the compensating device 300 via an IP address. In that way there are displayed images, logos, photos, animations, tables imported from a database or videos in different formats.

[0060] As the compensating devices 300 are configurable via network an alternative version of the first and second preferred embodiment offers a function that the look-up table or formula for calculating the compensation values for the cells are updated via the network continuously in accordance with the newest data concerning the phosphors used in the cells or other properties of the displays. Additionally the compensation values are updated or refreshed via this function by a system administrator 510.

[0061] This embodiment also offers the possibility to update the programs, formulas and look-up tables by replacing an EPROM or flash memory of the programmable signal processing device.

[0062] Another alternative of the first and second preferred embodiments of the present invention, is that the compensating device 300 is integrated into a plasma display or in an information display. Integrating the compensating device 300 into an information display offers the opportunity that redundant parts like processor, hard disk, random access memory, PCI bus, etc. have to be provided only once.

[0063] In a further alternative to the first and second preferred embodiments of the present invention the compensating device 300 may be provided as a PCI slot card which is connectable to the PCI bus of an information display. In that way the compensating device 300 is integrated in already existing information displays in a very economic and effective way.

[0064] The relationship between life-times, stress levels, ambient temperatures, average brightness levels is very complex. It requires a high level a data sets, which describe the degradation of the primary phosphors red, green, and blue under the various operating conditions.

[0065] The proposed software concept, which traces the stress levels of display load, the number of address ability of single picture elements, sustain frequency control and ambient temperature will provide the data for future automatic software and hardware compensation algorithm.

[0066] In the following a calibration system is proposed for analysing and compensating the actual brightness of the plasma display cells. The gathered data are processed, stored, and distributed to the information display for a pixel wise compensation. The calibration system is a complete solutions for on-side compensation on installed information displays.

[0067] FIG. 6 illustrates a schematic diagram of a third preferred embodiment of the present invention. A calibration system is shown for calibrating a compensation value of cells of information display to compensate the degradation of the light output of the cells. The calibration system comprises a compensating device 300 in accordance with the first and second preferred embodiments of the present invention. Furthermore the calibration system comprises an electronic camera 620 for taking screen images of the plasma display for measuring the brightness of the cells of the information display and a laptop 630 or computer, which is connected to the electronic camera and to the compensating device 300. The electronic camera 620 is transmitting data of the taken screen image to the computer or laptop and the laptop or computer is transforming the transmitted data of the electronic camera to compensation values of the cells of the plasma display. Furthermore the PC or laptop is transmitting the calculated compensation values via a serial, parallel or Ethernet interface to the compensating device 300 where the values are stored in the compensation frame buffer.

[0068] Alternatively the PC or laptop provides only the date concerning brightness and the duration of the brightness of the cells and transmits this data to the compensating device 300 where the compensation values are calculated.

[0069] Preferably a progressive high resolution CCD camera is used with a 12 bit accuracy and a digital output to ensure signal fidelity. The data of the CCD camera is outputted via a RS422 to the measurement PC or a laptop. Furthermore a high performance lens is used for the CCD camera to provide a distortion free image of the screen. This is necessary in the case that the compensation values for each single cell of the plasma or information display has to be calibrated.

[0070] FIG. 7 illustrates a schematic diagram of the camera 620 in accordance with a third preferred embodiment of the present invention. The camera is assembled to a black chamber head. The head is a black ended box with one open side. The camera is located opposite to the open side of the center of that area. The area of the open side is equivalent to the display screen size.

[0071] For collecting data the black box with the camera is moved against the surface of the screen. The black box eliminates effects resulting from ambient light sources and reflections. The measuring box uses soft and flexible edges at the open side to close the junction between box and display surface.

[0072] The camera takes the screen images with its digital sensor. Best suited is a sensor resolution which corresponds to the physical resolution of the display device under test. The camera transmits an image data via a serial link to the measurement PC or laptop. The software running on the computer processes the data and generates the compensation values pixel by pixel or cell by cell for the three primary colors red, green and blue.

[0073] Referring back to Fig. 6 in addition to the above mention alternative the tables or matrices with the compensation values are transferred to a server 640 in a computer network to be stored. Each of the displays within the network has its own network address. This clear identification tool allows the storage of compensation matrices and remote distribution from the server to the displays.

[0074] The server or the local direct links save the data to the embedded compensating device. The compensation values are added as positive or negative values to a compensation correction software tool or saved into a dedicated second video memory or in the compensation frame buffer.

[0075] For taking the measurement data full screen images of a black screen (R 0, G 0, B 0), of a 80% white screen (R 208, G 208, B 208), of a red screen (R 208, G 0, B 0), of a green (R 0, G 208, B 0), and a blue screen (R 0, G 0, B 208) are taken.

[0076] For fixed patterns the compensation software adds the compensation data to the image data before writing the data into the video memory or buffers. For moving pictures a computer processor speed is not sufficient enough. An additional embedded signal processor adds the data from the image video memory or video frame buffer with the data from the compensation memory or compensation frame buffer and transfers the final results to the buffers or directly to the connected display.

[0077] The compensation can be done by multiplying a positive or negative factor to the image data included in the video signal. As long as the display offers dynamic range for neutral compensation the positive factor will be the preferable method in order to keep the image performance and luminance (light output) on the level at the beginning of the product life. Multiplication increases the data in the video memory and keeps the brightness offset unchanged. The higher the data value the brighter the image on the screen.

[0078] The analysis software on the measurement PC checks the image array for the maximum, the minimum and the relative values. The maximum value corresponds to the picture element with the lowest stress level. The minimum value corresponds to the picture element with the strongest stress level.

[0079] By collecting data regarding the light output of each cell of the display, all effects for degradation of the phosphor efficiency are taken into account. The reasons for differences in light output are the operating time, average and peak brightness during operating time, cell temperature, basic light output variations (about 10%, not localised) and production process variations.

[0080] The maximum value equals to a compensation factor of 1. The minimum value requires a compensation factor to generate a light output which equals the luminance of the cell with the maximum measurement values. All other values are equally distributed between the maximum and the minimum values. Depending on the color depths used a limited and discrete number of compensation values can be offered. This limitation might cause small variations in luminance output from picture element to element.

[0081] Nevertheless, the dynamic range of an information display comes to its end, also with compensation, but much later. At that moment compensation of an equally distributed luminance can still be maintained. However the constant distribution requires a lower total luminance of the display. From that time on the minimum luminance value has to be taken as the reference to compensate all other sub-pixels against the sub-pixel with the lowest light output.

[0082] The measurement cycles are directly related to the offered degradation of the performance of the installed display devices and the kind of information displayed on the screen.

[0083] The visibility of the phosphor decay depends, besides the stress levels for the picture cells, on the used color selection. When using character with changing mixed colors on a dark or grey background the visibility of the degradation occurs later.

[0084] When using characters with strong primary colors with maximum intensity on a white background the degradation becomes obvious much earlier. In such applications differences of less than 5% in luminance can be detected on the screen.

[0085] Additional screen savers during the non-operating hours, orbiting systems and periodic change of the page layouts or the line structure and position of the information automatically equal the stress levels of the single cells and prolong the time interval between active phosphor compensation additionally to compensation device.

[0086] In relation to the above characteristics of an information display application, service intervals between 6 months and 24 months seem to be realistic for the nowadays available quality of plasma display devices. This offers the possibility to use an effective calculation method to calculate the compensation values for compensating the degradation between two service periods without the need to consider all physical stress levels in the formula. Nevertheless, a good color quality is maintained within the service interval. Updating the matrices of the compensation values for every pixel with the calibration system brings back the full color quality to the display.

[0087] The measurement time and phosphor compensation can be a manual and an automated process. The duration of an automated process is less than half an hour.

[0088] The above stated scenarios are not technology dependent. So this compensation method can also be used in the case of a worn out CRT.

Claims

1. A device for compensating a degradation of a light output of a cell of a plasma display which occurs during the operation of the plasma display, comprising
   means for providing and storing data concerning brightness and duration of said brightness of at least one cell of the plasma display over a specified time period; and
   means for providing a compensation value for the at least one cell of the plasma display for compensating the degradation of the light output of the at least one cell based on the stored data of the at least one cell to ensure that the brightness of the cell corresponds approximately to a brightness of a cell with a non-degraded light output.

2. The device for compensating a degradation of a light output according to claim 1, wherein the device for compensating a degradation of a light output further comprises a graphics controller adapted for generating a video signal for displaying pictures on the plasma display and wherein the means for providing a compensation value further comprises:

   a programmable signal processing device comprising a compensation frame buffer for storing the compensation value for the at least one cell of the plasma display;

   a high speed multiplication unit for correcting video signals using the compensation value of the at least one cell; and

   a buffer for storing the results of the high speed multiplication,

   wherein the high speed multiplication unit is connected to the graphics controller for receiving video signals generated by the graphics controller and to the programmable signal processing device for receiving the compensation values.

3. The device for compensating a degradation of a light output according to claim 2, wherein the high speed multiplication unit is connected to a buffer, which is receiving the results of the high speed multiplication unit and is providing these results to the plasma display.

4. The device for compensating a degradation of a light output according to claims 2 or 3, wherein the programmable signal processing device is connected to a graphics controller and synced by said graphics controller via said connection.

5. The device for compensating a degradation of a light output according to any of claims 2 to 4, wherein the programmable signal processing device determines the compensation values for the at least one cell based on data stored for the cell using a look-up table.

6. The device for compensating a degradation of a light output according to any of claims 2 to 4, wherein the programmable signal processing device calculates the compensation values for the at least one cell based on stored data for the cell using a specific formula.

7. The device for compensating a degradation of a light output according to any of claims 2 to 6, wherein the programmable signal processing device determines the compensation values based on the stored data of the cell after a specified time interval and stores it in the compensation frame buffer.

8. The device for compensating a degradation of a light output according to any of claims 2 to 7, wherein the programmable signal processing determines the compensation values based on the stored data for the cell within a time interval according to the refresh rate of the plasma display and stores the compensation values in the compensation frame buffer.

9. The device for compensating a degradation of a light output according to any of claims 2 to 8, wherein the programmable signal processing device further comprises a configuration unit with an interface for inputting data for changing the compensation value of the at least one cell in the compensation frame buffer.

10. The device for compensating a degradation of a light output according to any of claims 2 to 9, wherein an initial value for the compensation value of the at least one cell is stored in the compensation frame buffer, so that an initial maximum adjustable brightness of the at least one cell is limited to a specific percentage of a maximum allowable brightness of the at least one cell.

11. The device for compensating a degradation of a light output according to any of claims 2 to 10, wherein the programmable signal processing device provides compensation values for each single cell of the plasma display based on the stored data

regarding the degradation of different phosphors used in different cell types and stores the compensation values for each single cell in the compensation frame buffer.

12. The device for compensating a degradation of a light output according to any of claims 2 to 11, wherein the programmable signal processing device is a FPGA (field programmable gate array).

13. The device for compensating a degradation of a light output according to any of claims 2 to 12, wherein the video signals of the graphics controller contains 24 bit video data.

14. The device for compensating a degradation of a light output according to any of claims 1 to 13, wherein the means for providing and storing data is integrated in the programmable signal processing device.

15. The device for compensating a degradation of a light output according to any of claims 1 to 14, wherein the means for providing and storing data are providing and storing data for the at least one cell within a time interval according to the refresh rate at which the plasma display is operated.

16. The device for compensating a degradation of a light output according to any of claims 1 to 15, wherein the means for providing and storing data are providing and storing data at every refresh cycle the plasma display is operated with.

17. The device for compensating a degradation of a light output according to any of claims 1 to 16, wherein the means for providing and storing data are accumulating provided data with already stored data and are storing the accumulated data in the compensation frame buffer.

18. The device for compensating a degradation of a light output according to any of claims 1 to 17, wherein the means for providing and storing data are separately storing accumulated data for each single cell of the plasma display, which represents the brightness and duration of brightness of the cells of the plasma display over a certain time period.

19. The device for compensating a degradation of a light output according to claim 18, wherein the programmable signal processing device provides compensation values for each single cell of the plasma display based on the stored accumulated data of each single cell regarding the degradation of different phosphors used in different cell types and stores the compensation values for each single cell in the compensation frame buffer at every refresh cycle the plasma display is operated with.

20. The device for compensating a degradation of a light output according to any of claims 1 to 19, wherein device for compensating a degradation of a light output further comprises an interface to connect to a computer network or a telecommunication network and to which the programmable signal processing device is connected.

21. The device for compensating a degradation of a light output according to any of claims 1 to 20, wherein the programmable signal processing device is configured or updated via the interface to the computer network or a telecommunication network.

22. The device for compensating a degradation of a light output according to claim 1, wherein the device for compensating a degradation of a light output further comprises a graphics controller adapted for generating a video signal for displaying pictures on the plasma display and wherein the means for providing a compensation value further comprises a programmable signal processing device comprising a compensation frame buffer for storing the compensation value for the at least one cell of the plasma display, wherein the programmable signal processing device is connected to the graphics controller for receiving the signals for correcting the video signals using the compensation value of the at least one cell.

23. The device for compensating a degradation of a light output according to claim 22, wherein the means for providing and storing data concerning brightness and duration of the brightness are integrated in the means for providing the compensation value.

24. The device for compensating a degradation of a light output according to claims 22 or 23, wherein the compensation frame buffer is a flash memory or a random access memory or a hard disk.

25. The device for compensating a degradation of a light output according to any of claims 22 to 24, wherein the programmable signal processing device determines the compensation values for the at least one cell based on data stored for the cell using a look-up table.

26. The device for compensating a degradation of a light output according to any of claims 22 to 24, wherein the programmable signal processing device calculates the compensation values for the at least one cell based on stored data for the cell using a specific formula.

27. The device for compensating a degradation of a light output according to any of claims 22 to 26, wherein the programmable signal processing device further comprises a configuration unit with an interface for inputting data for changing the compensation value of the at least one cell in the compensation frame buffer.

28. The device for compensating a degradation of a light output according to any of claims 22 to 27, wherein the device for compensating a degradation of a light output further comprises an interface to connect to a computer network or a telecommunication network and to which the programmable signal processing device is connected.

29. The device for compensating a degradation of a light output according to any of claims 22 to 28, wherein the programmable signal processing device is configurable via the interface over a computer network or a telecommunication network.

30. The device for compensating a degradation of a light output according to any of claims 22 to 29, wherein an initial value for the compensation value of the at least one cell is stored in the compensation frame buffer, so that an initial maximum adjustable brightness of the at least one cell is limited to a specific percentage of a maximum allowable brightness of the at least one cell.

31. The device for compensating a degradation of a light output according to any of claims of 22 to 30, wherein the programmable signal processing device provides compensation values for each single cell of the plasma display based on the stored data regarding the degradation of different phosphors used in different cell types and stores the compensation values for each single cell in the compensation frame buffer.

32. The device for compensating a degradation of a light output according to any of claims 22 to 31, wherein the means for providing and storing data are separately storing accumulated data for each single cell of the plasma display, which represents the brightness and duration of brightness of the cells of the plasma display over a certain time period.

33. The device for compensating a degradation of a light output according to claim 32, wherein the programmable signal processing device provides compensation values for each single cell of the plasma display based on the stored accumulated data of each single cell regarding the degradation of different phosphors used in different cell types and stores the compensation values for each single cell in the compensation frame buffer at every refresh cycle the plasma display is operated with.

34. The device for compensating a degradation of a light output according to any of claims 22 to 33, wherein the means for providing and storing data are providing and storing data at every refresh cycle the plasma display is operated with and wherein the programmable signal processing device provides compensation values at every refresh cycle the plasma display is operated with.

35. A plasma display panel, wherein the device for compensating a degradation of a light output according to any of claims 1 to 34 is integrated.

36. An information display panel, wherein the device for compensating a degradation of a light output according to any of claims 1 to 34 is integrated.

37. A calibration system for calibrating a compensation value for at least one cell of the plasma display to compensate the degradation of the light output of the at least one cell, comprising:

the device for compensating a degradation of a light output according to claims 9 to 21 or 27 to 34;

an electronic camera for taking screen images of the plasma display for measuring brightness of at least one cell of the plasma display; and

an electronic device connected to the electronic camera and the configuration unit of the device for compensating a degradation of a light output,

wherein the electronic camera is transmitting data of the taken screen images to the electronic device, the electronic device is transforming the transmitted data to compensation values for the at least one cell of the plasma display and is transmitting the compensation values to the configuration unit to change the compensation value of the at least one cell in the compensation frame buffer.

38. The calibration system for calibrating according to claim 37, wherein the electronic device is a computer or a laptop.

39. The calibration system for calibrating according to claims 37 or 38, wherein the electronic camera for taking screen images of the plasma display for measuring brightness of every cell of the plasma display.

40. The calibration system for calibrating according to any of claims 37 to 39, wherein the electronic device is transforming the transmitted data to compensation values for every cell of the plasma display and is transmitting the compensation values the configuration unit to change the compensation value of every cell in the compensation frame buffer.

41. A method for compensating a degradation of a light output of a cell of a plasma display which occurs during the operation of the plasma display, comprising the steps of
providing and storing data concerning brightness and duration of said brightness of at least one cell of the plasma display over a specified time period; and
providing a compensation value for the at least one cell of the plasma display for compensating the degradation of the light output of the at least one cell based on the stored data of the at least one cell to ensure that the brightness of the cell corresponds approximately to a brightness of a cell with a non-degraded light output.

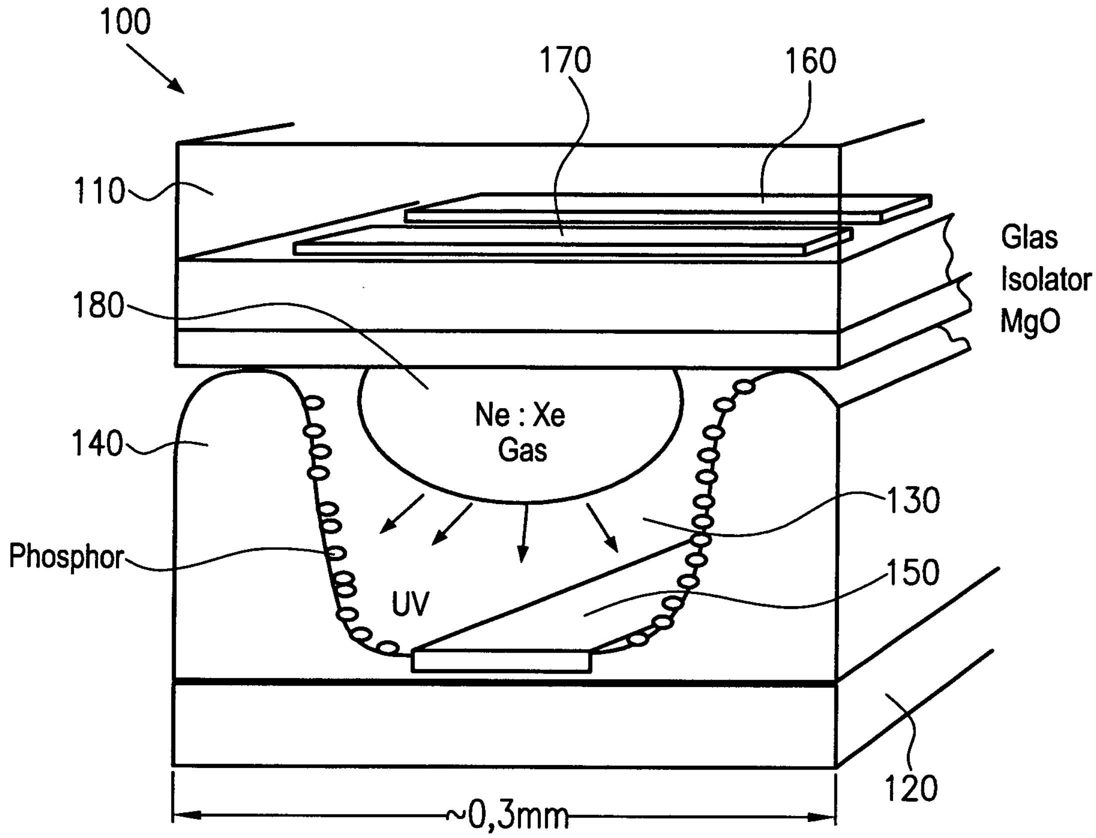

100
170
160
110
Glas
Isolator
MgO
180
Ne : Xe
Gas
140
130
Phosphor
150
UV
120
~0,3mm

Fig. 1

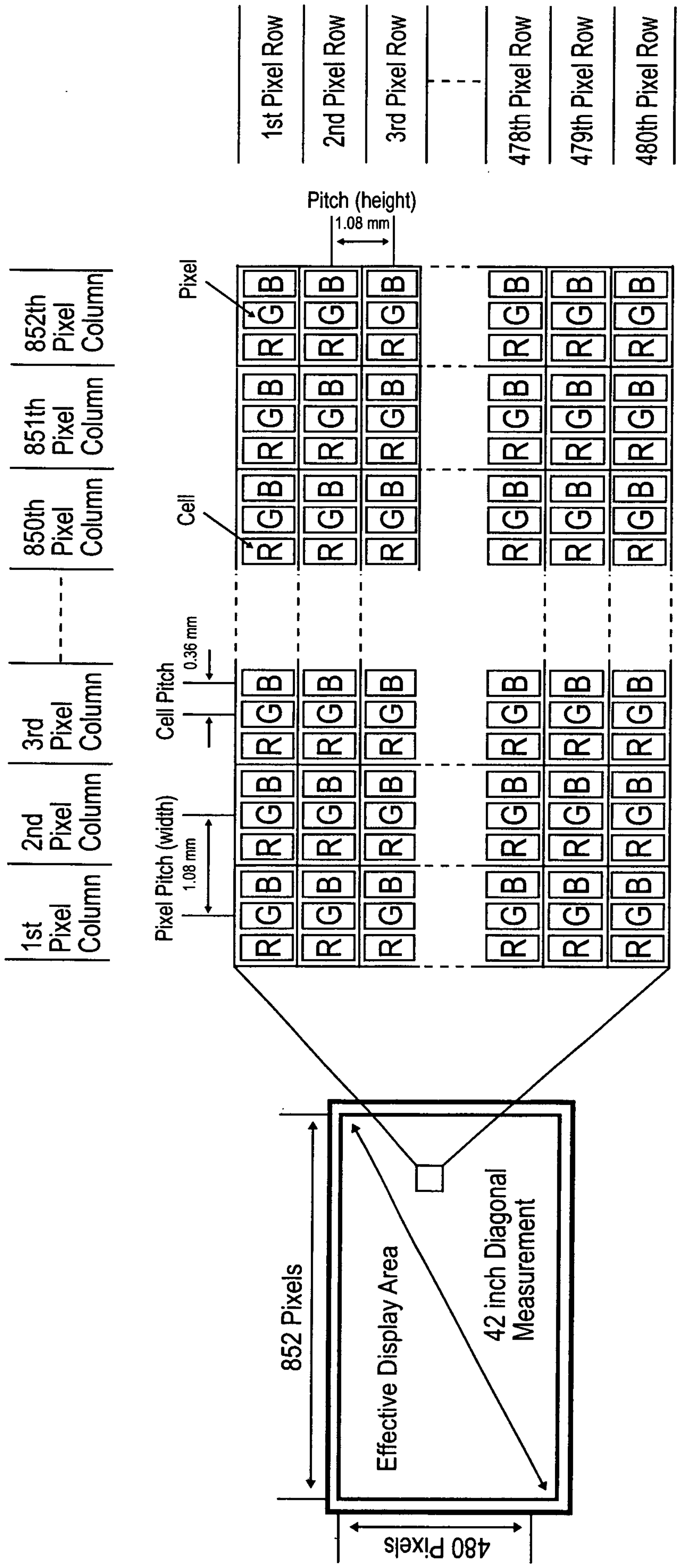

1st Pixel Row
2nd Pixel Row
3rd Pixel Row
478th Pixel Row
479th Pixel Row
480th Pixel Row
Pitch (height)
1.08 mm
1st Pixel Column
2nd Pixel Column
3rd Pixel Column
850th Pixel Column
851th Pixel Column
852th Pixel Column
Pixel
Cell
Cell Pitch
0.36 mm
Pixel Pitch (width)
1.08 mm
R
G
B
852 Pixels
480 Pixels
Effective Display Area
42 inch Diagonal Measurement

Fig. 2

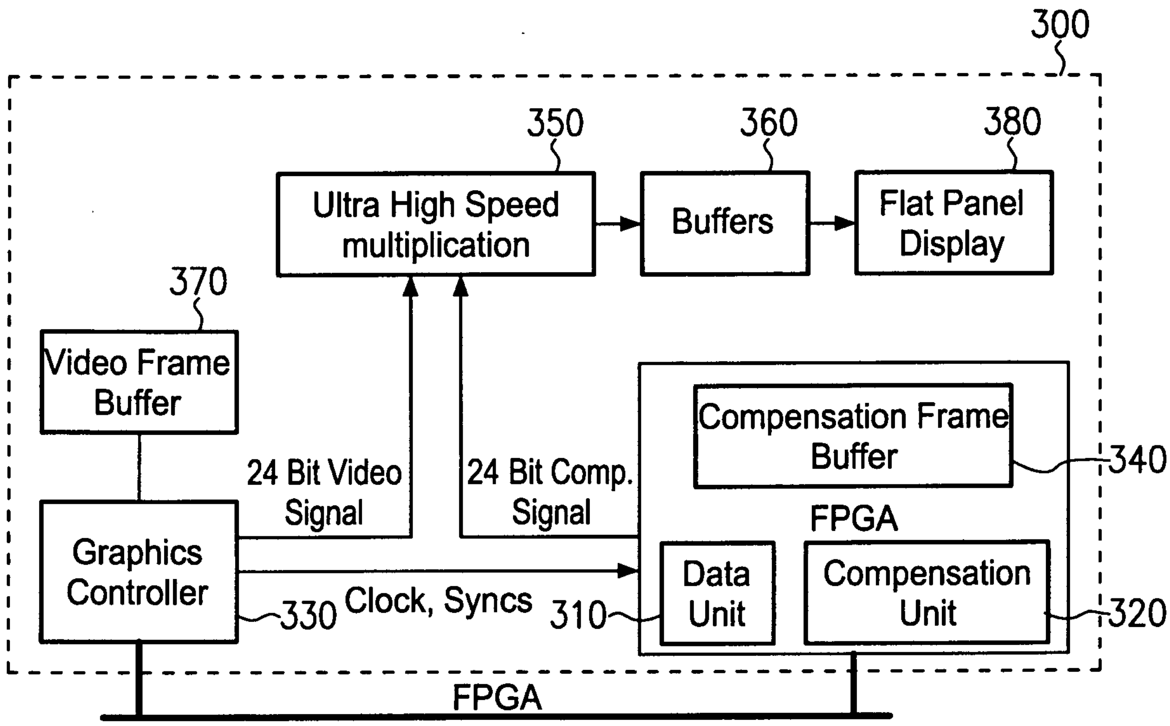

300
350
360
380
Ultra High Speed multiplication
Buffers
Flat Panel Display
370
Video Frame Buffer
24 Bit Video Signal
24 Bit Comp. Signal
Compensation Frame Buffer
340
FPGA
Graphics Controller
Data Unit
Compensation Unit
330
Clock, Syncs
310
320
FPGA

Fig. 3

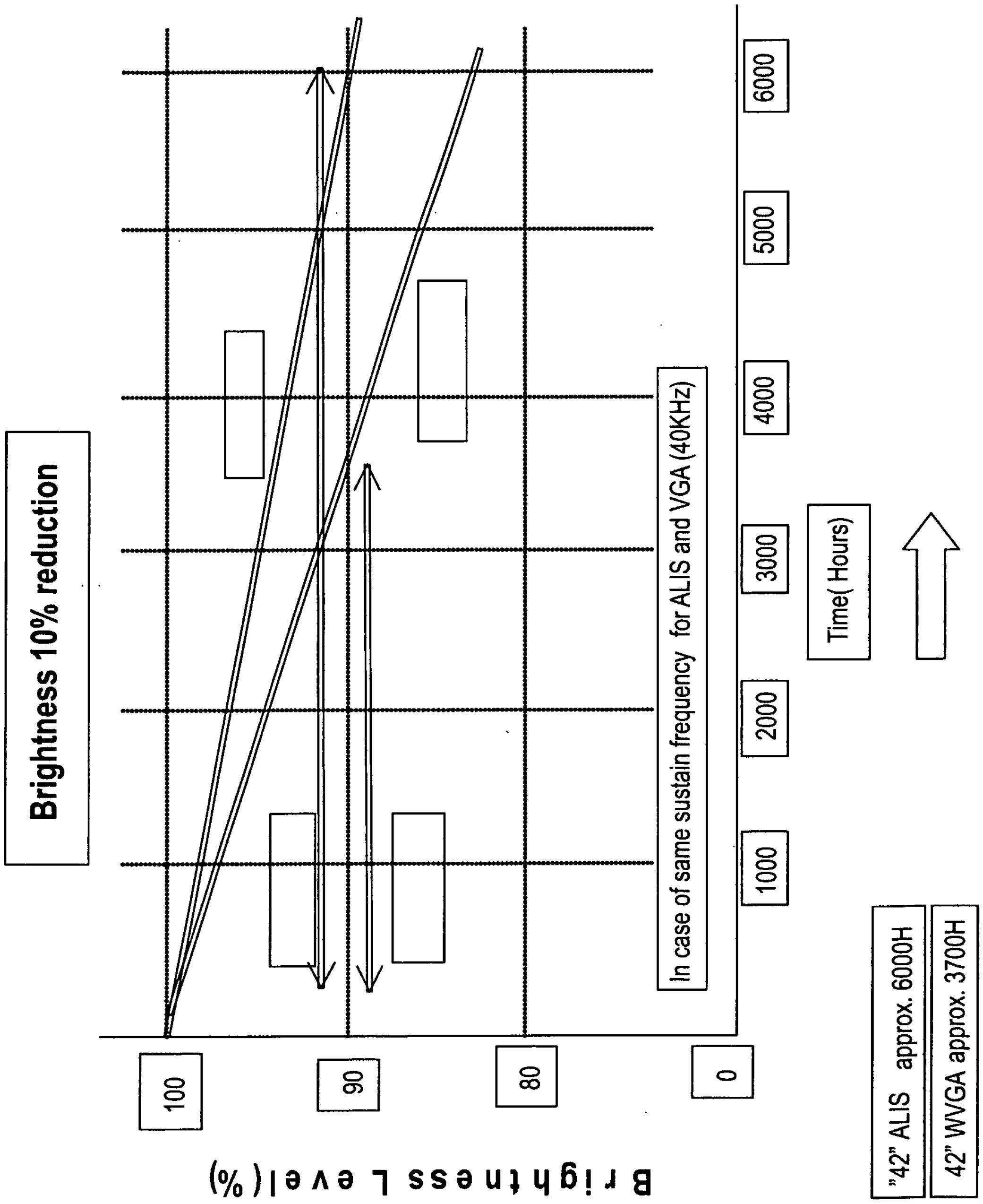

Brightness 10% reduction
In case of same sustain frequency for ALIS and VGA (40KHz)
Time(Hours)
1000
2000
3000
4000
5000
6000
100
90
80
0
Brightness Level (%)
"42" ALIS approx. 6000H
42" WVGA approx. 3700H

Fig. 4

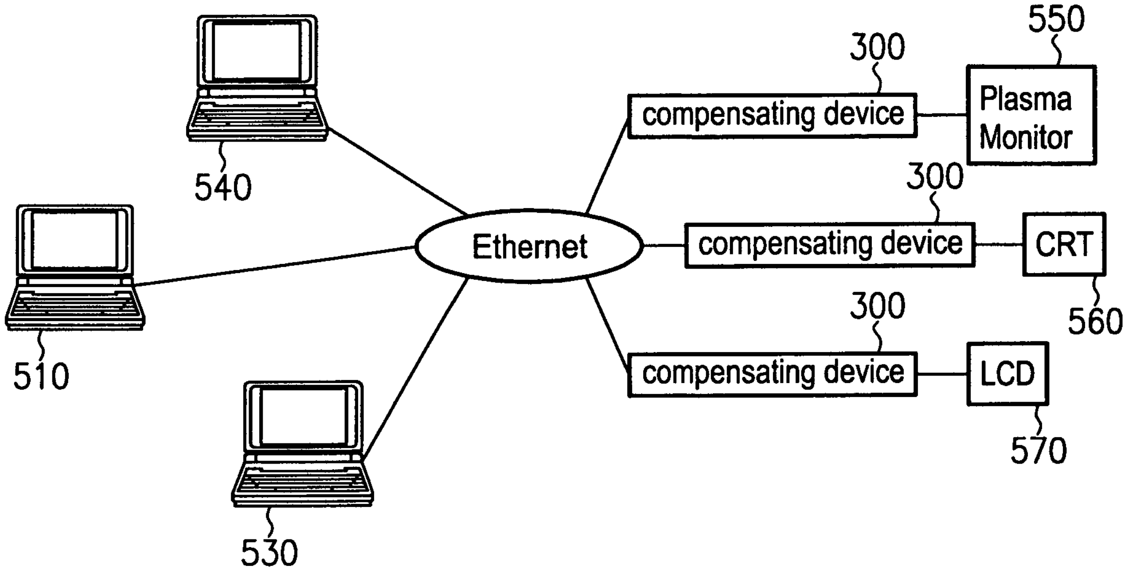
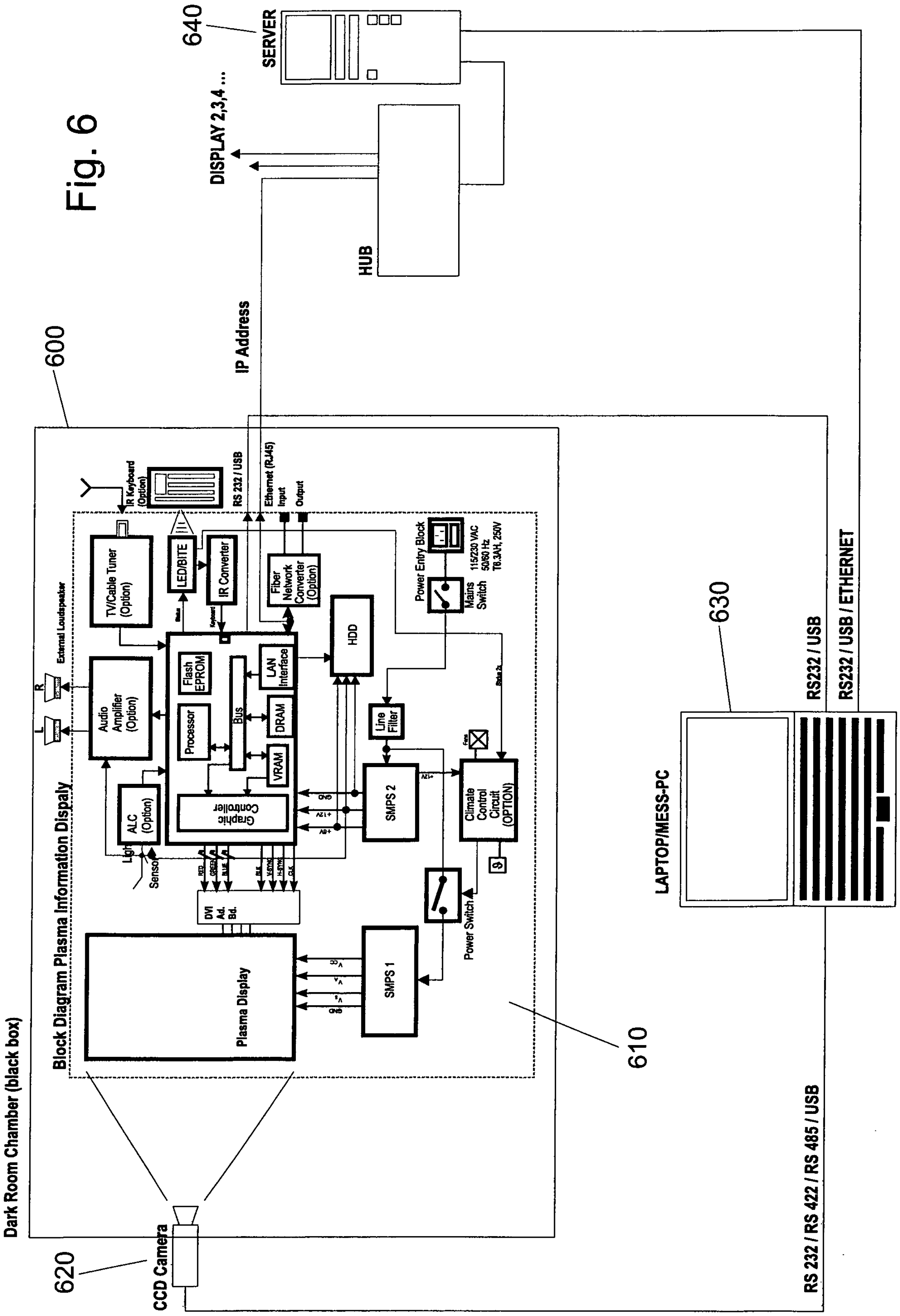

540
510
530
Ethernet
300
compensating device
300
compensating device
300
compensating device
550
Plasma Monitor
CRT
560
LCD
570

Fig. 5

Fig. 6



600
610
620
630
640
Dark Room Chamber (black box)
Block Diagram Plasma Information Dispaly
CCD Camera
SERVER
HUB
DISPLAY 2,3,4 ...
IP Address
LAPTOP/MESS-PC
RS232 / USB
RS232 / USB / ETHERNET
RS 232 / RS 422 / RS 485 / USB
RS 232 / USB
Ethernet (RJ45)
Input
Output
External Loudspeaker
TV/Cable Tuner (Option)
Audio Amplifier (Option)
ALC (Option)
LED/BITE
IR Converter
IR Keyboard (Option)
Fiber Network Converter (Option)
Flash EPROM
Processor
Bus
LAN Interface
DRAM
VRAM
Graphic Controller
HDD
Line Filter
Power Entry Block
Mains Switch
115/230 VAC
50/60 Hz
T6.3AH, 250V
SMPS 2
SMPS 1
Climate Control Circuit (OPTION)
Power Switch
Plasma Display
DVI Ad. Bd.
Light Sensor

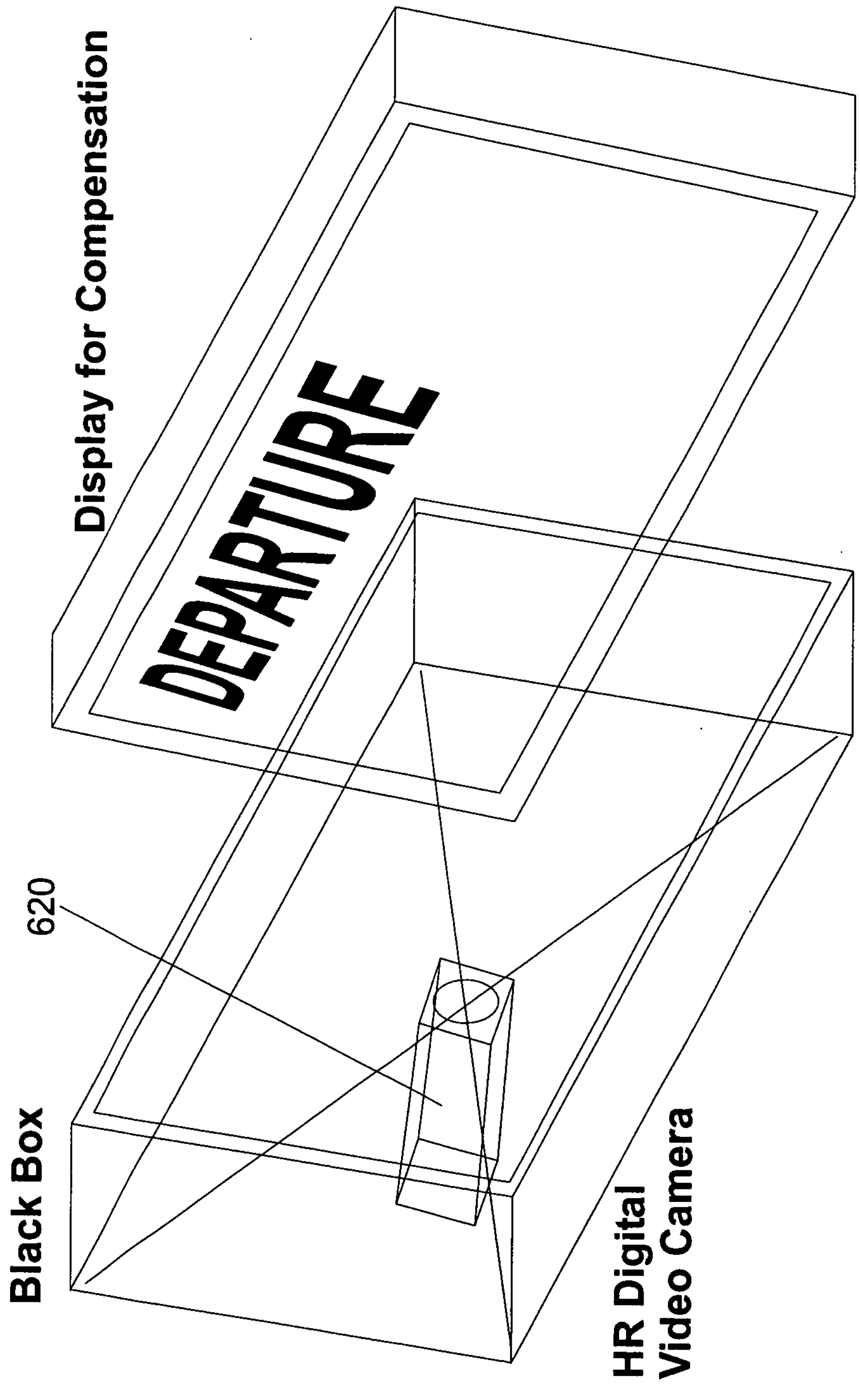

Display for Compensation
DEPARTURE
620
Black Box
HR Digital
Video Camera

Fig. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 01 7703

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y A	US 6 271 825 B1 (GREENE ET AL) 7 August 2001 (2001-08-07) * abstract * * column 4, line 23 - line 63 * * column 5, line 31 - line 36 * ---	1-6, 17-19,41 20-41 7-16	G09G3/28
X Y A	US 6 414 661 B1 (MATTHIES DENNIS LEE ET AL) 2 July 2002 (2002-07-02) * abstract * * column 2, line 59 - column 3, line 67 * * column 6, line 3 - line 53 * * column 8, line 55 - column 9, line 1 * ---	1-6, 17-19,41 20-40 7-16	
Y	WO 99 10866 A (IMAGICOLOR CORP) 4 March 1999 (1999-03-04) * abstract * * page 1, line 6 - line 16 * * page 14, line 11 - page 15, line 17 * * page 20, line 7 - line 28 * * page 25, line 21 - page 26, line 4 * * page 28, line 5 - line 12 * * page 77, line 4 - page 79, line 1; figures 3,23-32 * ---	20-41	TECHNICAL FIELDS SEARCHED (Int.Cl.7) G09G
A	EP 1 047 040 A (NIPPON ELECTRIC CO) 25 October 2000 (2000-10-25) * abstract * * column 2, line 43 - column 3, line 35 * * column 6, line 55 - column 7, line 42; figures 1-5 * -----	1-41	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 May 2003	O'Reilly, D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 02 01 7703

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

08-05-2003

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			WO	9910866	A1	04-03-1999
			US	6459425	B1	01-10-2002
			US	2003020703	A1	30-01-2003
EP 1047040	A	25-10-2000	JP	2000284743	A	13-10-2000
			EP	1047040	A1	25-10-2000
			US	6288495	B1	11-09-2001

EPO FORM P0459

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