(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 223 570 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
08.10.2014 Bulletin 2014/41

(51) Int Cl.:
G09G 3/34 *(2006.01)*

(21) Application number: **01309446.1**

(22) Date of filing: **07.11.2001**

(54) **Apparatus and method for automatic brightness control of the backlight for use in a liquid crystal display device**

Vorrichtung und Verfahren zur automatischen Helligkeitseinstellung von der Rückbeleuchtung zum Verwenden in einer Flüssigkristallanzeige

Appareil et méthode de contrôle automatique de brillance de l'éclairage arrière à utiliser dans un affichage à cristaux liquides

(84) Designated Contracting States:
DE FR GB NL

(30) Priority: **29.12.2000 KR 2000085540**
14.05.2001 KR 2001026136

(43) Date of publication of application:
17.07.2002 Bulletin 2002/29

(60) Divisional application:
12157986.6 / 2 463 850

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- **PATENT ABSTRACTS OF JAPAN vol. 004, no. 131 (P-027), 13 September 1980 (1980-09-13) & JP 55 082375 A (SONY TEKTRONIX CORP), 21 June 1980 (1980-06-21)**
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EP 1 223 570 B1

Description

Field of the Invention

[0001] The present invention relates to a liquid crystal display (LCD) device, and more particularly to an apparatus and method for automatic brightness control for use in the LCD device.

Background of the Invention

[0002] An LCD or thin film transistor liquid crystal display (TFT-LCD) module is generally used as a display device in a system such as a portable computer, a television set, and a monitor. FIG. 1 shows a structure of a general LCD module 100. Referring now to FIG. 1, the LCD module 100 comprises an LCD panel 10 for displaying all sorts of information having a liquid crystal material between two glass substrates, a driving unit having driving circuits 20, 30 for driving the LCD panel 10 and a timing controller 40 for generating control signals to control the driving circuits 20, 30, a backlight 60 for guiding light to the LCD panel 10, and a chassis (not shown) for holding and protecting the LCD panel 10 and components of the backlight 60.

[0003] The backlight 60 includes an inverter 62, a fluorescent lamp 64 such as a cold cathode fluorescent tube (CCFT) or a hot cathode fluorescent tube (HCFT), and a plurality of sheets including a reflecting sheet 66 for guiding light to the front. The backlight 60 functions to guide light from the fluorescent lamp 64 to the LCD panel 10. The LCD panel 10 displays color images by shielding or passing light from the backlight 60 through each pixel therein in response to a signal voltage of respective corresponding pixel inputted from the driving circuits 20, 30.

[0004] FIG. 2 is a block diagram showing a conventional backlight brightness control scheme of the LCD module 100 when it is used as a display device in a portable computer or a desktop computer. The portable computer or desktop computer is generally driven by the direct current, whereas the backlight 60 is lit up on by the alternating current. Thus, it is essential for the LCD module 100 to have the inverter 62 for transforming the direct current into the alternating current as shown in the drawing. The inverter 62 includes a dimming circuit (not shown) to control the brightness of the fluorescent lamp 64 as well as to transform the direct current into the alternating current, as well known in the art.

[0005] Referring to FIG. 2, in the operation, as a brightness control command is inputted by the computer operation of user, a central processing unit (CPU) or main body 200 of the computer generates a brightness control voltage CTL_V for controlling brightness, to the inverter 62. In response to the brightness control voltage CTL_V from the main body 200, the dimming circuit of the inverter 62 controls an amount of current of the fluorescent lamp 64 to adjust the brightness of the backlight 60. For example, If the computer is a portable computer, the brightness control voltage CTL_V is within the range of 0 through 3.3 V. That is, when the brightness control voltage CTL_V is 0 V, a most dark brightness, i.e., black appears, and when the brightness control voltage CTL_V is 3.3 V, a most light brightness, i.e., white appears.

[0006] However, the conventional brightness control scheme of the LCD module is characterized that once the brightness is controlled, a value or level of the controlled brightness is unchanged even though the properties of data for each picture or frame to be displayed through the LCD module 100 vary. That is, the conventional brightness control scheme may raise a problem that increases the power consumption since the brightness is uniformly maintained regardless of a change in light and darkness between frames or a quick change of pictures or frames such as in motion images. Also, a picture of red (R) or blue (B) color of low transmissivity is not greatly brightened, no matter how much the brightness of the backlight may be increased. Therefore, in this case, the effect obtained through increasing the brightness is small compared to the power consumption increase.

[0007] US5717422 discloses a display including a light modulator, a source of light, and a control for controlling the intensity of light from the source supplied to the light modulator thereby to provide images of good contrast for both bright and dark scenes. A method of displaying an image using a passive light modulating display apparatus is disclosed which includes controlling the intensity of light illuminating the display apparatus as a function of a brightness characteristic of the image.

[0008] WO99/63515 relates to a colour balancing system for a display apparatus. Two planar light pipes are positioned, a first over a second, with an air gap between. The first light pipe is optically coupled to receive light from a first light source having a colour temperature above the predetermined range and the second light pipe is optically coupled to receive light from a second light source having a colour temperature below the predetermined range.

[0009] WO 00/68926 discloses an image display device and method therefor, which improves a visual contrast feeling by regulating a contrast and light source with a correlation maintained therebetween. A feature detection unit detects MAX, MIN and APL of an input image signal. A control data generating unit determines Gain for amplifying the difference between the MAX and the MIN up to a dynamic range width, and Offset for affording a DC level shift amount at which the input image signal to be amplified by the Gain falls within the output dynamic range of a DC level regulating unit. A signal amplitude regulating unit amplifies the input image signal based on the APL and according to the Gain. The DC level regulating unit level-shifts the amplified input image signal according to the Offset value. The light source control

unit controls a light source based on the Offset so that a visual brightness level on the screen is identical with a brightness level of the input image signal.

[0010] JP55082375 discloses how to make a circuit stable against temperatures, high-precision, and strong against noise and make it possible to obtain the product of large-amplitude analogue input signals by constituting the circuit by a control means consisting of a comparator circuit and a triangular wave generation circuit, a switch means, and an average means.

[0011] US5057744 discloses a luminous data display system is used to improve readability depending on fluctuations in the light environment. It has automatic means to adjust the luminance of the image produced on a screen. These means use a first sensor close to the screen to obtain an indication of the ambient illumination received by the screen, and a second sensor, preferably placed on the helmet, to appreciate the distribution of luminance perceived in the observer's field of vision. Circuits process the detected signal and a manual adjustment signal to produce a correction signal applied to the image video signal.

Summary of the Invention

[0012] Therefore, the present invention is applied in an improved apparatus and method for automatic brightness control for use in an LCD device, which can automatically control a brightness for each picture by controlling a duty rate for each picture automatically.

[0013] It is an object of the present invention to provide an improved apparatus and a method for automatic brightness control in an LCD device that can properly accommodate a brightness control by a user request and an automatic brightness control for each picture without conflicts therebetween.

[0014] It is another object of the present invention to provide an improved apparatus and a method for automatic brightness control for use in an LCD device which can improve a contrast for each picture displayed through an LCD module.

[0015] It is a further object of the present invention to provide an improved apparatus and a method for automatic brightness control for use in an LCD device, which can reduce the power consumption of an LCD module, by controlling a brightness according to data characteristic for each picture.

[0016] It is still another object of the present invention to provide an improved apparatus and a method for automatic brightness control for use in an LCD device, which can control a brightness of backlight corresponding to a state of red (R), green (G) and blue (B) colors of a picture to be displayed in the LCD device, and thereby reduce the power consumption of the LCD module.

[0017] Disclosed herein is an apparatus for automatic brightness control for use in an LCD device having a backlight, comprising control signal generating means for receiving an image data to be displayed through the LCD device, calculating an average gray level of the image data for one horizontal line period of the corresponding image, the image data being represented by a number of bits per pixel, and generating a brightness control signal having a high level, a low level and a duty rate that is in proportion to the average gray level, and an inverter for controlling a brightness of the backlight automatically in response to the brightness control signal from the control signal generating means.

[0018] According to an aspect of the present invention, there is provided an apparatus for automatic brightness control or use in an LCD device having a backlight in accordance with Claim 1.

[0019] According to another aspect of the present invention, there is provided a method for automatic brightness control for use in an LCD device comprising the steps of, calculating an average gray level of an image data for one horizontal line period of the corresponding image, to be displayed through the LCD device, the image data being represented by a number of bits per pixel, generating a first brightness control signal having a high level, a low level and a duty rate that is in proportion to the average gray level, generating a second brightness control signal through the main body of the computer by a user and controlling a brightness of backlight in response to a third brightness control signal generated according to the first and second brightness control signals.

[0020] Also disclosed is an apparatus for automatic brightness control for use in an LCD device having a backlight, which is used with a host of outputting a video information, comprising control signal generating means for receiving a pixel data corresponding to the video information, determining a color state of the pixel data, and generating a brightness control signal having a duty rate for controlling a brightness of the backlight corresponding to the determined color state, and an inverter for controlling automatically the brightness of the backlight in response to the brightness control signal from the control signal generating means.

[0021] The brightness control signal may have a duty rate reduced in order of green, red, and blue when the determined

[0022] color state is green, red, and blue. The duty rate of the brightness control signal is set to have a rate of green : red : blue = 1 : 0.66 : 0.49 when the determined color state is green, red, and blue. The control signal generating means can be formed of a timing controller,

[0023] The control signal generating means may include a control unit for controlling various operations of the first control signal generating means to determine the color state of the pixel data and to generate the first brightness control

signal, a pixel data acquisition and conversion unit for receiving the pixel data from the host and converting the pixel data according to the determined color state under the control of the control unit, a computing unit for computing the converted data logically and outputting a certain data under the control of the control unit, a down-counter for down-counting the certain data under the control of the control unit, and a pulse generator for generating the first brightness control signal corresponding to an output signal of the down-counter. The control unit controls to generate the first brightness control signal corresponding to an output signal of the down-counter until it comes to a logic low level.

[0024] Also disclosed is a method for automatic brightness control for use in an LCD device having a backlight, which is used with a host of outputting a video information, comprising the steps of receiving a pixel data corresponding to the video information, determining a color state of the pixel data, converting the pixel data according to the determined color state, determining whether the pixel data is a last data of one horizontal line period, outputting a brightness control signal corresponding to the pixel data when the pixel data is the last data of one horizontal line period, and controlling a brightness of the backlight in response to the brightness control signal.

[0025] The converting step may comprise converting the pixel data to have a duty rate corresponding to a brightness reduced in order of green, red, and blue when the determined color state is green, red, and blue. Preferably, the pixel data are converted into data corresponding to 100%, 66% and 49% of a maximum brightness when the determined color state is green, red, and blue, respectively.

Brief Description of the Drawings

[0026] The foregoing and other objects, features and advantages of the invention will become more apparent from the following detailed description of preferred embodiments thereof made with reference to the attached drawings.

FIG. 1 is a schematic perspective view showing a structure of a general LCD module.
FIG. 2 is a block diagram showing a conventional backlight brightness control scheme of an LCD module.
FIG. 3 is a block diagram showing a backlight brightness control scheme of an LCD module which is applied in the present invention.
FIG. 4 is a diagram showing waveforms of a variable brightness control voltage outputted from a duty controller and an R-C circuit when the backlight brightness control scheme of FIG. 3 is applied to the present invention.
FIG. 5 is a diagram showing waveforms of a variable brightness control voltage outputted from a duty controller and an R-C circuit when the backlight brightness control scheme of FIG. 3 is applied to the present invention.
FIG. 6 is a diagram showing a relation between the current and the brightness of a lamp linearly determined according to the variable brightness control voltage outputted from the duty controller and the R-C circuit when the backlight brightness control scheme of FIG. 3 is applied to the present invention.
FIG. 7 is a diagram showing a brightness for each color in a general 64 gray level TFT LCD.
FIG. 8 is a block diagram showing the duty controller in the backlight brightness control scheme of the LCD module shown in FIG. 3.
FIG. 9 is a flowchart showing an automatic brightness control program of the duty controller in the backlight brightness control scheme of the LCD module possibly used in the present invention.
FIG. 10 a diagram showing the power consumption of an LCD module where the program of the flowchart of FIG. 9 is used, monitored in real time.
FIG. 11 is a block diagram showing a backlight brightness control scheme of an LCD module in accordance with a preferred first embodiment of the present invention.
FIG. 12 is a diagram showing the results of the backlight brightness control carried out by the backlight brightness control scheme of the LCD module shown in FIG. 11 and the results of the contrast display according thereto.
FIG. 13 is a diagram showing the power consumption when the backlight brightness is controlled by the backlight brightness control scheme of the LCD module shown in FIG. 11.
FIG. 14 is a block diagram showing a backlight brightness control scheme of an LCD module in accordance with a preferred second embodiment of the present invention.
FIG. 15 is a block diagram showing a backlight brightness control scheme of an LCD module in accordance with a preferred third embodiment of the present invention.
FIG. 16 is a diagram showing output waveforms at each of function blocks shown in FIG. 15.
FIG. 17 is a flowchart showing an automatic brightness control method for use in an LCD module in accordance with the present invention.

Detailed Description of Preferred Embodiments

[0027] The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. Like numbers refer to like elements throughout.

[0028] An LCD device suitable for use in the present invention automatically controls a brightness of backlight according to a duty rate signal generated in proportion to an average gray level of pixels to be displayed in the LCD device.

[0029] FIG. 3 is a block diagram showing a backlight brightness control scheme of such an LCD module, which is applied to a portable computer or desktop computer. Referring to FIG. 3, the LCD module includes a timing controller 400 having a duty controller 420 for calculating an average of gray levels in terms of one horizontal line period, i.e., 1H, to one picture or frame to be displayed on the LCD module and generating a duty rate signal DUTY corresponding to the calculated average value of the gray levels, and an R-C circuit 500 for summating the duty rate signals DUTY generated in terms of 1H from the timing controller 400 during one frame and generating a variable brightness control voltage Vduty that changes the electric potential in proportion to the gray levels of the picture to be displayed. An inverter 62 connected to the R-C circuit 500 controls an amount of current of a fluorescent lamp 64 through a dimming circuit (not shown) to adjust brightness of the backlight in response to the variable brightness control voltage Vduty.

[0030] The operation of this LCD module will now be described in detail with reference with the drawings.

[0031] First, the timing controller 400 outputs pulse waves in terms of 1H. Each pulse wave has a duty rate corresponding to an average value of gray levels of pixel data for 1H. For example, in an LCD module with a VGA resolution having 640 pixels for 1H, if an average value of gray levels of all pixels for 1H is 'black', a duty rate signal DUTY of 0 % which outputs a logic high value as much as 0 pixel clock is generated. If an average value of gray levels of all pixels for 1H is 'white', a duty rate signal DUTY of 100 % which outputs logic high values as much as 640 pixel clocks is generated. Also, if an average value of gray levels of all pixels for 1H is 'middle' grade, a duty rate signal DUTY of 50 % is generated.

[0032] Tables 1 and 2 illustrated below show duty rates as percentages in an LCD module having a VGA resolution where the number of horizontal pixels is 640 and the number of an average gray level in 1 horizontal line is 16. In particular, Table 1 shows duty rates when a gamma constant is 1, whereas Table 2 shows duty rates when a gamma constant is 2.2.

[Table 1]

GRAY LEVEL	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DUTY [%]	0	6.7	13.3	20	26.7	33.3	40.0	46.7	53.3	60.0	66.7	73.3	80.0	86.7	93.3	100
PIXEL CLOCK [Number]	0	43	85	128	171	213	256	299	341	384	427	469	512	555	597	640

[Table 2]

GRAY LEVEL	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DUTY [%]	0	0.3	1.2	2.9	5.5	8.9	13.3	18.7	25.1	32.5	41.0	50.5	61.2	73.0	85.9	100
PIXEL CLOCK [Number]	0	2	8	19	35	57	85	120	161	208	262	323	392	467	550	640

[0033] In Tables 1 and 2, each duty rate indicates the number of pixels having logic high values for 1H as a percentage. Accordingly, the duty rate signals DUTY generated from the timing controller 400 output pulse waves, each of which has logic high values as much as the number of pixel clocks as illustrated in Tables 1 and 2 according to the average value of the gray levels of the pixel data for 1H.

[0034] In order to generate the duty rate signals DUTY, the duty controller 420 of the timing controller 400 includes a memory buffer register (MBR) or a storage register to calculate the average value of gray levels of pixel data for 1H. For example, supposing that in case a 4 bit pixel data able to indicate 16 gray levels is inputted, an average value of gray levels to 1H among data of 1 frame is calculated, first the duty controller 420 deletes data stored in the register every 1H. Then, the duty controller 420 receives a 4 bit pixel data, summates it to a value accumulated in the register and stores the summated result in the register. And then, until a 4 bit pixel data corresponding to the end of the 1 horizontal line is inputted, i.e., all 4 bit pixel data of the 1 horizontal line are inputted, the duty controller 420 repeats the summation operation as described above. Thereafter, when all 4 bit pixel data of the 1 horizontal line are inputted, the duty controller 420 selects 4 bit data of the highest rank among a data stored in the register and generates a duty rate signal DUTY for 1H outputting high values as much as the number of pixel clocks shown in Tables 1 and 2. Thus, the duty rate signal DUTY for the 4 bit data expressing the 16 gray levels is generated. In case of 6 or 8 bit pixel data, the duty control principle of the duty controller 420 can be applied as the 4 bit pixel data explained above.

[0035] When the duty controller 420 generates the duty rate signal DUTY corresponding to the average gray level in terms of 1H, the R-C circuit 500 accumulates the duty rate signals DUTY generated from the timing controller 400 over 1 frame and output a variable brightness control voltage Vduty according thereto.

[0036] The operation of the R-C circuit 500 will now be described in detail.

[0037] First, supposing that an initial charged voltage of a capacitor is Vo and a signal of 1H having an amplitude Vc and a high duration time T1, i.e., a high duty rate signal (D=T1/1H*100%) is outputted from the timing controller 400, a variable brightness control voltage Vduty outputted from the R-C circuit 500 every 1H is defined as the following mathematical formula.

[Mathematical formula 1]

$$Vduty=\{Vo+(Vc-Vo)x\ [1-EXP[-T1/(Rx\ C)]]\}x\ EXP\{(T1-1H)/(R\ x\ C)]$$

[0038] As apparent from the formula, the variable brightness control voltage Vduty for controlling the brightness of the backlight has a voltage level in proportion to the high duration time T1 of the duty rate signal DUTY generated from the timing controller 400, and the response time of the variable brightness control voltage Vduty is determined by means of an RC time constant of the R-C circuit 500.

[0039] FIG. 4 is a diagram showing waveforms of the variable brightness control voltage Vduty outputted from the duty controller 420 and the R-C circuit 500 shown in FIG. 3. Referring to FIG. 4, graphs 1 and 2 show waveforms of the variable brightness control voltages Vduty of 0-15 gray levels (duty rate of 100%) and a middle gray level (duty rate of 50%), respectively, when the RC time constant is ten times as much as 1H. In this case, the variable brightness control voltage Vduty comes to a saturation state at 50H. This means that the duty rate of 50H is determined by means of the RC time constant of the R-C circuit 500.

[0040] FIG. 6 is a diagram showing a relation between the current and the brightness of the lamp 64 linearly determined according to the variable brightness control voltage Vduty outputted from the duty controller 420 and the R-C circuit 500 shown in FIG. 3. Referring to FIG. 6, when the variable brightness control voltage Vduty outputted from the R-C circuit 500 is used as an input voltage of the inverter 62 of the backlight, the inverter 62 generates a current CTL_I corresponding to the inputted variable brightness control voltage Vduty. The brightness of the backlight is determined in proportion to an amount of the current.

[0041] As apparent from the relation between the current and the brightness, the LCD module of the present invention generates the variable brightness control voltage Vduty by automatically controlling duty rates for one picture to be displayed thereon, and adjusts the brightness of the backlight automatically by controlling the amount of current of the lamp 64 generated through the inverter 62 according to the variable brightness control voltage Vduty.

[0042] An LCD module can automatically control a brightness of backlight by generating a variable brightness control voltage having a duty rate corresponding to a color state of pixel data from a duty controller and controlling an amount of current of the backlight, i.e., a fluorescent lamp in response to the variable brightness control voltage. Alternatively, the LCD module can be set to generate the variable brightness control voltage having the duty rate corresponding to the average gray level of the pixel data from the duty controller, as previously described, with reference to the first embodiment as well as the color state of the pixel data.

[0043] Referring to FIG. 7, a brightness magnitude of white is obtained by summating brightness magnitudes of green (G), red (R) and blue (B). For example, if the brightness magnitudes of the three colors are 73.62, 29.45 and 21.24 respectively, the brightness magnitude of white comes to 124.3. This means that in a color filter of the TFT LCD, the transmissivity of R, G and B is determined in order of G > R > B. Accordingly, in the present invention, when R, G and B are displayed at a same gray level, the brightness magnitude is controlled to be lowered in order of G, R and B. That is, the brightness of the backlight is maximized at G, thereby to feel the picture or image more brightly. Also, the brightness of the backlight is set to be lowered at R and B to reduce the power consumption of the LCD module. The reason is that a picture of G which shows a high transmissivity is more brightly seen even though the brightness of the backlight is slightly increased, whereas pictures of R and B which show a low transmissivity are not bright enough compared with increase of the power consumption, however much the brightness may be increased.

[0044] FIG. 3 is a block diagram showing an LCD module to which such a backlight brightness control scheme applied. The composition and operation in this LCD module is the same as in the LCD module previously described, except generating a variable brightness control voltage having a duty rate corresponding to a color state of pixel data from a duty controller and controlling an amount of current of the backlight according to the variable brightness control voltage. In the embodiment, the transmissivity is set at a rate of G : R : B=1 : 0.66 : 0.49, so that pictures of G, R and B generate a maximum brightness, a half of the maximum brightness, and a quarter of the maximum brightness, respectively.

[0045] Referring to FIG. 3, the LCD module comprises a timing controller 400, an R-C circuit 500, an inverter 62, and a lamp 64.

[0046] The timing controller 400 includes a duty controller 420 and components of an integrated circuit of a general timing controller such as an input processor, a signal processor, a clock processor, and a data processor that are not shown in the drawing. The duty controller 420 generates a duty rate signal DUTY for controlling the brightness of the backlight automatically in response to a color state of a pixel data inputted from a host (not shown), for example,

[0047] As shown in FIG. 8, the duty controller 420 includes a pixel data acquisition and conversion unit 421, an adder 422, a summer 423, a divider 424, a duty register/down-counter 426, a pulse generator 427 and a control unit 428.

[0048] The pixel data acquisition and conversion unit 421, which has a plurality of memory registers, for example R, G, and B registers and accumulation registers, receives a pixel data R[5:0], G[5:0], B[5:0] from the host outputting a video information and generates a pixel data R'[5:0], G'[5:0], B'[5:0] converted according to a color state R, G, B through given processes S40 through S54 of FIG. 9. The adder 422 adds the converted pixel data R'[5:0], G'[5:0], B'[5:0] generated from the pixel data acquisition and conversion unit 421 and stores it. When the added pixel data SUM[7:0] is data for one horizontal line period 1H, the summer 423 summates the accumulated data in the adder 422 and stores the summated result. The divider 424 divides the sum total TSUM[17:0] of the pixel data for 1H outputted from the summer 423 by a divisor, for example 3. The duty register/down-counter 426 loads 6 bit data MSB[15:10] of the highest rank among data outputted from the divider 424 and down-counts them. This can set, levels for controlling the brightness according to the color state, since the 6 bit data MSB[15:10] of the highest rank correspond to 64 gray levels of white through black. The pulse generator 427 outputs a duty rate signal DUTY corresponding to an output signal of the duty register/down-counter 426 to the R-C circuit 500.

[0049] The control unit 428 receives a pixel clock signal CLK and a video signal DE having an information of 1H from the host to clear the registers (not shown) of the pixel data acquisition and conversion unit 421 periodically, and generates load signals DATA_LOAD1, DATA_LOAD2, a clock signal DOWN_COUNT, control signals PIXEL_ADD, LINE_ADD, DIV for controlling the calculation operation such as addition, summation, and division, so as to control the operation of each component of the duty controller 420 properly.

[0050] The operation of this last described LCD module will now be described.

[0051] First, an R, G, B data of 6 bits, for example a pixel data in which G[5:0] is 111111 and R[5:0] and B[5:0] are 000000 is inputted into the pixel data acquisition and conversion unit 421 from the host. The pixel data acquisition and conversion unit 421 then converts it into a pixel data in which G'[5:0], R'[5:0] and B'[5:0] are 111111 respectively, under the control of the control unit 428. And then, the adder 422 adds the converted pixel data, i.e., G'[5:0] + R'[5:0] + B'[5:0]. As a result, the added pixel data SUM[7:0] comes to 10111101. The summer 423 receives the added pixel data SUM[7:0] and accumulates them for 1H. For example, in case of a LCD module of an XGA having 1024 pixels for one horizontal

line a data TSUM[17:0] accumulated for 1H becomes to 101111010000000000, if a pixel data for 1H having G[5:0] of 111111 and R[5:0] and B[5:0] of 000000 is inputted.. Thereafter, the divider 424 divides the accumulated data TSUM[17:0] by 3. The result of dividing the accumulated data TSUM[17:0] by 3 is 1111110000000000. The duty register/down-counter 426 loads 6 bit data MSB[15:10] of the highest rank among data outputted from the divider 424, into a duty register therein, and down-counts them in response to a down-count clock signal DOWN_COUNT outputted from the control unit 428. At this time, the down-count clock signal DOWN_COUNT is a clock signal having a period divided a time of 1H by the number 2^6 (64) which can be presented by 6 bits. Accordingly, the pulse generator 427 outputs a duty rate signal DUTY corresponding to an output signal of the duty register/down-counter 426 while values of the duty register are down-counted. That is, the pulse generator 427 maintains an output signal in a high level state until the down-counted value of the duty register comes to 000000. For this, the pulse generator 427 can be formed of an 1 bit input OR gate in which each bit of the duty resistor is an input. Thus, when the pixel data in which G[5:0] is 111111 and R[5:0] and B[5:0] are 000000 is inputted, a duty rate signal of 100% which is in a high level state for 1H is outputted. Of course, when pixel data in which R[5:0] is 111111 and G[5:0] and B[5:0] are 000000, and B[5:0] is 111111 and G[5:0] and R[5:0] are 000000 are inputted, duty rate signals of 66% and 49% of a maximum brightness are respectively outputted for 1H.

[0052] Referring now to FIG. 3, the R-C circuit 500 generates a variable brightness control voltage Vduty in response to the duty rate signal DUTY from the duty controller 420. The duty rate signal DUTY has a duty rate determined according to the color state of the pixel data. For example, as described above, when the color state of the pixel data is green, red and blue, the duty rate signal DUTY has a duty rate of 100%, 66%, and 49% of the maximum brightness, respectively.

[0053] The inverter 62 receives the variable bright control voltage Vduty from the R-C circuit 500 and outputs a current CTL_I for controlling the brightness of the backlight 60, i.e., the fluorescent lamp 64. Accordingly, the brightness of the backlight 60 is automatically controlled in proportion to the current CTL_I.

[0054] Thus, in the LCD module of the invention, the duty controller 420 of the timing controller 400 outputs the duty rate signal Duty having the duty rate corresponding to the color state of the picture to be displayed, and the R-C circuit 500 generates the variable brightness control voltage Vduty according to the duty rate signal DUTY. The inverter 62 controls the amount of the current CTL_I of the fluorescent lamp 64 in response to the variable brightness control voltage Vduty to adjust the brightness of backlight 60 automatically.

[0055] FIGs. 5 and 6 are diagrams showing waveforms of the variable brightness control voltage Vduty and the output current CTL_I of the inverter 62.

[0056] Referring to FIGs. 5 and 6, the R-C circuit 500 outputs the variable brightness control voltage Vduty that is linearly determined in proportion to the duty rate signal DUTY. Accordingly, the inverter 62 generates the current CTL_I for controlling the brightness of the backlight determined linearly according to the variable brightness control voltage Vduty, and thereby the LCD module carries out an automatic brightness control function corresponding to the duty rate signal DUTY outputted according to the color state of R, G and B.

[0057] FIG. 9 is a flowchart showing an automatic brightness control program of the duty controller 420 of the LCD module in accordance with the second embodiment of the present invention. The program which are carried out by the duty controller 420 are stored in an inner memory (not shown) of the control unit 428.

[0058] Referring to FIG. 9, first the control unit 428 clears R, G, B registers of the pixel data acquisition and conversion unit 421 (S40). The R, G, B registers then latches a pixel data R[5:0], G[5:0], B[5:0] outputted from the host (S42). And then, the control unit 428 determines whether a value of the G register is not 0 and values of the R, B registers are 0, respectively (S44). When the result of the step S44 is YES, the value of the G register is loaded into the R, G registers (S46) and otherwise, the control unit 428 determines whether a value of the R register is not 0 and values of the G, B registers are 0, respectively (S48). Continually, when the result of the step S48 is YES, a half of the value of the R register is loaded into the G, B registers (S50) and otherwise, the control unit 428 determines whether a value of the B register is not 0 and values of the R, G registers are 0, respectively (S52). When the result of the step S52 is YES, a quarter of the value of the B register is loaded into the R, G registers (S54). These steps show that the pixel data R[5:0], G[5:0], B[5:0] is transformed into a data R'[5:0], G'[5:0], B'[5:0] according to the color state thereof.

[0059] Continually, when the result of the step S52 is NO, the control unit 428 controls the adder 422 to add the values of the R, G, B registers (S56). Then, the control unit 428 determines whether the present pixel data is a last data of 1H (S58). When the determined result of the step S58 is No, the operation step is returned to the second step S42 to repeat the operations of S42 through S56 as described above.

[0060] And then, when the result of the step S58 is YES, the divider 424 divides an accumulated data TSUM[17:0] of the R, G, B registers by 3 and the duty register/down-counter 426 stores 6 bit data MSB[15:10] of the highest rank among data outputted from the divider 424, in the duty register (S60). Continually, the duty register/down-counter 426 down-counts the values MSB[15:10] of the duty register (S62).

[0061] The pulse generator 427 determines whether the down-counted value of the duty register is 0 (S64). In result, when it is NO, the pulse generator 427 outputs a duty rate signal DUTY corresponding to the down-counted value of the duty register and otherwise, the program is ended.

[0062] The operation of the control unit 428 will now be described in detail by using an example which the pixel data

of R, G, B explained with reference to FIG. 8 are 6 bit data, respectively.

[0063] First, the control unit 428 clears the R, G, B registers of the pixel data acquisition and conversion unit 421. The R, G, B registers then latches a pixel data R[5:0], G[5:0], B[5:0] outputted from the host.

[0064] At this time, when a value of the G register is not 0 and values of the R, B registers are 0 respectively, the value of the G register is loaded in the R, G registers. When a value of the R register is not 0 and values of the G, B registers are 0 respectively, a half of the value of the R register is loaded in the G, B registers. Also, when a value of the B register is not 0 and values of the R, G registers are 0 respectively, a quarter of the value of the B register is loaded in the R, G registers. For example, in case of 6 bit pixel data, when a value G[5:0] of the G register is 101010 and values R[5:0], B[5:0] of the R, B registers are 000000 respectively, each of the R, G, B registers loads 101010 which is the value G[5:0] of the G register. When a value R[5:0] of the R register is 101010 and values G[5:0], B[5:0] of the G, the B register are 000000 respectively, the R register loads 101010 and the G, B registers load 010101 that is a half of the value R[5:0] of the R register. In other words, the value R[5:0] of the R register is shifted one bit to the right. Also, when a value B[5:0] of the B register is 101010 and values R[5:0], G[5:0] of the R, G registers are 000000 respectively, the B register loads 101010 and the R, G registers load 001010 which is a quarter of the value B[5:0] of the B register. In other words, the value B[5:0] of the B register is shifted two bits to the right. In cases other than the three cases explained above, the operations are skipped.

[0065] Continually, the control unit 428 controls the adder 422 to add the values of R, G, B registers. The added value SUM[7:0] is then accumulated in the R, G, B registers. And then, the divider 424 divides the accumulated data TSUM[17:0] of the R, G, B registers by 3 and the duty register/down-counter 426 stores 6 bit data MSB[15:10] of the highest rank among data outputted from the divider 424, in the duty register. In succession, the duty register/down-counter 426 down-counts the values [15:10] of the duty register and at the same time, the pulse generator 427 outputs a duty rate signal DUTY having a duty rate corresponding to the value of the duty register that outputs signal of logic 1, until the down-counted value of the duty register comes to 000000. At this time, the duty rate signal DUTY has a period of 1H. Also, the down-count clock signal DOWN_COUNT is a clock signal having a period divided a time of 1H by the number 2^6 (64) which can be presented by 6 bits.

[0066] Supposing that in case of a pixel data of white in which R[5:0], G[5:0], B[5:0] are 111111 respectively, the result of converted pixel data, i.e., R'[5:0]+G'[5:0]+B'[5:0] is 189 and a duty rate is 100%, when a pixel data G[5:0] is 111111 and pixel data R[5:0], B[5:0] are 000000 respectively, a converted pixel data R'[5:0], G'[5:0], B'[5:0] of the R, G, B registers come to 111111 respectively and R'[5:0]+G'[5:0]+B'[5:0] comes to 189, to generate a duty rate signal DUTY of 100%. Also, when a pixel data R[5:0] is 111111 and pixel data G[5:0], B[5:0] are 000000 respectively, a converted pixel data R'[5:0] of the R register comes to 111111 and converted data G'[5:0], B'[5:0] of the G, B registers come to 011111 respectively and R'[5:0]+G'[5:0]+B'[5:0] comes to 125 and generate a duty rate signal DUTY of 66%. Also, when a pixel data B[5:0] is 111111 and pixel data R[5:0], G[5:0] are 000000 respectively, a converted pixel data B'[5:0] of the B register becomes 111111 and converted data R'[5:0], G'[5:0] of the R, G registers become 001111 respectively, rendering R'[5:0]+G'[5:0]+B'[5:0] as 93 and generate a duty rate signal DUTY of 49%. That is, when a brightness of one of R, G and B is white, the duty rate signals having the duty rates of 66%, 100%, and 49% respectively are generated. Thus, according to the color state of R, G and B, a different brightness is outputted. Particularly, a brightness magnitude is reduced in the order of G, R and B, so that a contrast for each picture displayed on the LCD module can be improved and the power consumption can be reduced.

[0067] FIG. 10 shows the results of monitoring the power consumption in real time when motion images, for example, a file of DVD format are played. As shown in FIG. 10, the power consumption of the LCD module in accordance with the present invention was about 4.1W, whereas the power consumption of the conventional brightness control method was 5.4W. Accordingly, the present invention can reduce an average power consumption of about 1.3W, compared to the conventional brightness control method. Also, as shown in the below Table 3, a driving time of battery in the present invention is extended about 2.23 hours compared with the conventional brightness control method when the same batteries having a power capacity of 38Wh were used.

[Table 3]

	The average power consumption	The driving time of battery
The conventional method	5.4W	7.04h
The invention	4.1W	9.27h
Improvements	1.3W reduced	2.23h lengthened

Embodiment 1

[0068] An LCD module of the present invention can perform a brightness control requested by a user as well as an automatic brightness control for each picture. For this, the LCD module of the present invention includes a merging circuit that accommodates two control functions without conflicts. The composition of the LCD module having the merging circuit will now be explained.

[0069] FIG. 11 is a block diagram showing a backlight brightness control scheme of an LCD module in accordance with a preferred first embodiment of the present invention when it is used as a display device in a portable computer or a desk top computer. Referring to the drawing, the composition of the LCD module shown in FIG. 11 is the same as that of the LCD module shown in FIG. 3 except for a merging circuit 600 that generates a variable brightness control voltage Vduty to the R-C circuit 500 in response to the brightness control voltage CTL_V generated from a CPU or main body 200 of the computer and the duty rate signal DUTY generated from the duty controller 420 disposed in the timing controller 400. Accordingly, for facilitating the explanation, like numbers refer to like blocks having same function throughout. The explanation for the like blocks will not be repeated.

[0070] The merging circuit 600 includes a first transistor T1 having a base for receiving a duty rate signal DUTY in the terms of 1H connected to the timing controller 400 through the resistor R3, an emitter connected to an input end of the R-C circuit 500, and a collector for receiving the brightness control voltage from the main body 200 of the computer. T he emitter of the first transistor T1 is connected to a ground through a resistor R2. The first transistor T1 is composed of an NPN transistor. Here should be noted that the first transistor T1 forming the merging circuit is explained as an example, and other circuit elements such as NMOS transistors and operational amplifiers can be used to form it depending on the circuit design.

[0071] The first transistor T1 of the merging circuit 600 functions as a gating circuit for receiving the brightness control voltage CTL_V generated from the main body 200 of the computer and the duty rate signal DUTY generated from the duty controller 420, and outputting the brightness control voltage CTL_V selectively to the R-C circuit 500 when the duty rate signal DUTY is a high level. The R-C circuit 500 receives the brightness control voltage CTL_V selectively outputted from the merging circuit 600 to charge the capacitor C1, and generates a variable brightness control voltage Vduty by means of voltage charged to the capacitor C1. Here, it should be noted that the brightness control voltage CTL_V generated from the main body 200 of the computer can be freely set within the range of a given value by user and an electric potential of the variable brightness control voltage Vduty outputted through the R-C circuit 500 in the merging circuit 600 varies according to a gray level or/and a color state of a picture to be displayed.

[0072] For example, when a brightness control voltage CTL_V of 2V generated from the main body 200 of the computer is outputted to a terminal of the collector of the first transistor T1, the merging circuit 600 outputs a brightness control voltage CTL_V in response to a duty rate signal DUTY inputted to the base of the first transistor T1. The R-C circuit 500 charges the capacitor C1 by means of the brightness control voltage CTL_V selectively outputted according to the duty rate signal DUTY and outputs a voltage of 0-2V charged to the capacitor C1 as a variable brightness control voltage Vduty. Also, when a brightness control voltage CTL_V of 1V generated from the main body 200 of the computer is outputted to the terminal of the collector of the first transistor T1, the merging circuit 600 outputs a variable brightness control voltage Vduty of 0-1V through the R-C circuit 500 in response to a duty rate signal DUTY inputted to the base of the first transistor T1.

[0073] The duty rate signal DUTY inputted to the base of the first transistor T1 cannot only generate at the timing controller 400, but also at the LCD panel or a graphic controller (not shown) in the main body 200 of the computer. Accordingly, the merging circuit 600 can be disposed in the LCD panel or the main body 200 of the computer as well as a circuit substrate for the inverter 62 in the LCD module.

[0074] FIG. 12 is a diagram showing the results of the backlight brightness control performed by the LCD module shown in FIG. 11 and the results of the contrast display FIG. 13 is a diagram showing the power consumption according to the backlight brightness control performed by the LCD module shown in FIG. 11.

[0075] Referring to FIG. 12, it can be appreciated from the results of the backlight brightness control carried out by the LCD module of the present invention that in a dark picture such as 'black', the brightness of the invention was lower than that of the conventional technique, in a light picture such as 'white', the brightness of the invention was the same as that of the conventional technique, and 'contrast' showing the contrast of 'black' and 'white' in the invention was evidently higher than that of the conventional technique. Consequently, in the LCD module of the present invention, the contrast of 'black' and 'white' is more distinct, so that pictures to be displayed through the LCD module can be more lively felt.

[0076] Referring to FIG. 13, when the dark picture such as 'black' was displayed, the power consumption of the LCD module of the invention decreases by 2.2W than the conventional technique. When a picture such as 'mosaic pattern' representing the display of a general picture was displayed, the power consumption of the invention decreases by 0.9W than the conventional technique. Thus, since the LCD module of the present invention includes the merging circuit 600, the brightness for each picture can be actively controlled within the range of the brightness control voltage determined

from the main body 200 of the computer.

Embodiment 2

[0077] In the present invention, a PNP transistor can replace the NPN transistor T1 of the merging circuit 600. The composition of the merging circuit including the PNP transistor is shown in FIG. 14.

[0078] FIG. 14 is a block diagram showing a backlight brightness control scheme of an LCD module in accordance with a preferred second embodiment of the present invention when it is used as a display device in a portable computer or a desk top computer. Referring to FIG. 14, the composition of the LCD module is the same as that of the LCD module shown in FIG. 11 except for a merging circuit 600' having the PNP transistor T2 instead of the merging circuit 600 having the NPN transistor T1, and an R-C circuit 500' having a resistor R6 connected to an output end thereof. Accordingly, for facilitating the explanation, like numbers refer to like blocks having same function throughout. The explanation for the like blocks will not be repeated.

[0079] The merging circuit 600' includes a second transistor T2 having an emitter for receiving a brightness control voltage CTL_V from the main body 200 of the computer through a resistor R4, a base for receiving a duty rate signal DUTY in the terms of 1H connected to a timing controller 400 through a resistor R7, and a collector connected to a ground. The emitter of the second transistor T2 is connected to an input end of the R-C circuit 500'.

[0080] The second transistor T2 of the merging circuit 600' functions as a gating circuit for receiving the brightness control voltage CTL_V generated from the main body 200 of the computer and the duty rate signal DUTY generated from the duty controller 420, and outputting the brightness control voltage CTL_V selectively to the R-C circuit 500' when the duty rate signal DUTY is a high level. The R-C circuit 500' receives the brightness control voltage CTL_V selectively outputted from the merging circuit 600' to charge the capacitor C2, and generates a variable brightness control voltage Vduty by means of voltage charged to the capacitor C2. It should be noted that the brightness control voltage CTL_V generated from the main body 200 of the computer can be freely set within the range of a given value by user and an electric potential of the variable brightness control voltage Vduty outputted through the R-C circuit 500' changes according to a gray level or/and a color state of a picture to be displayed. The resistor R6 connected to an output end of the R-C circuit 500' distributes the variable brightness control voltage Vduty outputted through the R-C circuit 500' at a given rate.

[0081] Here, it should be noted that in the drawing, the second transistor T2 is illustrated as a PNP transistor, but it is explained as an example and other circuit elements such as NMOS transistors and operational amplifiers can be used to form it according to the circuit design method.

Embodiment 3

[0082] In the LCD module described above, when a brightness control voltage CTL_V of 0V generated from the main body 200 of the computer is outputted, a variable brightness control voltage Vduty of 0V cannot be outputted to the R-C circuit 500' due to a base-emitter voltage Vbe of the second transistor T2 in the merging circuit 600'. Accordingly, to remove the influence of the base-emitter voltage Vbe, a level shifter is added in the LCD module, as shown in FIG. 15.

[0083] FIG. 15 is a block diagram showing a backlight brightness control scheme of an LCD module in accordance with a third preferred embodiment of the present invention when it is used as a display device in a portable computer or a desk top computer. Referring to FIG. 15, the composition of the LCD module is similar to the LCD module shown in FIG. 14 except for a level shifter 700 interposed between the timing controller 400 and the merging circuit 600'. Accordingly, for facilitating the explanation, like numbers refer to like blocks having same function throughout. The explanation for the like blocks will not be repeated.

[0084] The level shifter 700 includes an NPN type third transistor T3 having an emitter connected to an input end of the merging circuit 600', a base connected to the timing controller 400 through a resistor R8, and a collector connected to a power source voltage V_{DD}, a resistor R9 having one end connected to the emitter, a diode D1 connected between the other end of the resistor R9 and a ground or earth, and a resistor R10 connected between the other end of the resistor R9 and a turn-off voltage Voff end of transistor.

[0085] The level shifter 700 generates a drop in voltage as much as a base-emitter voltage Vbe of the third transistor T3 on a current path comprising the ground, the diode D1, the resistors R9, R10, and the turn-off voltage Voff, for example, a voltage of below -5V, of the transistor and provides its drop value to a terminal of the emitter of the third transistor T3 and the resistor R9. Consequently, the transistor T2 of the merging circuit 600' is fully swung, so that even though a brightness control voltage CTL_V of 0V is outputted, a variable brightness control voltage Vduty of 0V can be outputted to the R-C circuit 500'.

[0086] The operation of the LCD module having the level shifter 700 will be explained with reference to FIG. 16 showing output wave forms at each node.

[0087] First, a duty rate signal DUTY of 0 to 3V generated from the timing controller 400 is inputted to the level shifter 700. When the duty rate signal DUTY is 0V, the level shifter 700 outputs a level shift voltage Vshift of -0.6V, i.e., -Vbe,

whereas when the duty rate signal DUTY is 3V, i.e., the power source voltage V_{DD} level, the level shifter 700 outputs a level shift voltage Vshift of 3V-Vbe, i.e., 2.4V. That is, the level shifter 700 generates the level shift voltage Vshift of -0.6 to 2.4V in response to the duty rate signal DUTY of 0 to 3V.

[0088] Next, when the level shift voltage Vshift generated from the level shifter 700 is inputted to the merging circuit 600' having the PNP transistor T2, the R-C circuit 500' outputs a variable brightness control voltage Vduty. For example, when the level shift voltage Vshift of -0.6V, i.e., -Vbe is inputted, an electrical potential of the emitter of the PNP transistor T2 becomes -0.6V(-Vbe)+Vbe to output a brightness control voltage CTL_V' of 0V. When the level shift voltage Vshift of 2.4V is inputted, the PNP transistor T2 outputs a brightness control voltage CTL_V' of 3V to the R-C circuit 500'. The emitter voltage CTL_V' of the PNP transistor T2, i.e., the brightness control voltage generated from the main body 200 of the computer is charged through the R-C circuit 500' and then outputted as a variable brightness control voltage Vduty. The variable brightness control voltage Vduty is outputted to the inverter 62 to control the brightness of the backlight. At the emitter voltage CTL_V' of FIG. 16, dotted lines show ranges of the brightness control voltage that can be controlled by user. Accordingly, the brightness of the backlight is automatically controlled within the ranges.

[0089] FIG. 17 is a flowchart showing an automatic brightness control method of the LCD module in accordance with the present invention. Referring to FIG. 17, the duty controller 420 of the timing controller 400 calculates an average value of gray levels in terms of 1H, to pixel data to be displayed in one picture (S10). Alternatively, at the step S10, the duty controller 420 can additionally carry out an operation for determining a color state of the pixel data for 1H. Then, the duty controller 420 generates a duty rate signal DUTY corresponding to the calculated average value of the gray levels or/and the determined color state to the merging circuit 600, 600' (S12). And then, the merging circuit 600, 600' generates a variable brightness control voltage Vduty in response to the duty rate signal DUTY and a brightness control voltage generated from the main body 200 of the computer, and the inverter 62 receives the variable brightness control voltage Vduty to control the brightness of the backlight automatically (S14).

[0090] Thus, the LCD module in accordance with the present invention merges the duty rate signals DUTY generated from the duty controller 420 of the timing controller 400 and the brightness control voltage CTL_V generated from the main body 200 of the computer by user setting, to control the brightness of the backlight automatically. As a result, as shown in FIGs. 12 and 13, the contrast for each picture displayed on the LCD module can be improved and thereby the power consumption can be reduced.

[0091] As apparent from the foregoing description, the present invention can automatically control the brightness for each picture by controlling the duty rate for each picture automatically.

[0092] Also, the present invention can properly combine the brightness control by a user request and the automatic brightness control function for each picture without conflicts.

[0093] Further, the present invention can improve the contrast for each picture displayed in the LCD module, and thereby reduce the power consumption of the LCD module.

[0094] Still further, the present invention can control the brightness of the backlight automatically by generating the variable brightness control voltage having the duty rate corresponding to the color state of pixel data from the duty controller, and thereby reduce the power consumption of the LCD module to extend battery usage in the system such as the portable computer.

[0095] Also, the present invention can control to feel pictures or images more brightly and thereby to experience a cubic effect when the pictures are changed from a dark color to a bright color since a brightness change of white and black for R, G and B colors is greatly enhanced by controlling the brightness according to the color state of R, G, and B of the pixel data.

[0096] In the drawings and specification, there have been disclosed typical preferred embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purpose of limitation, the scope of the invention being set forth in the following claims.

Claims

1. An apparatus for automatic brightness control for use in an LCD device (100) having a backlight (60), comprising:

first control signal generator arranged to receive an image data to be displayed on the LCD device (100), calculating an average gray level of the image data for one horizontal line period of the corresponding image, the image data being represented by a number of bits per pixel, and generating a first brightness control signal (DUTY) having a high level, a low level and a duty rate that is in proportion to the average gray level;

second control signal generator arranged to generate a second brightness control signal (CTL-V) to control brightness of the backlight (60) by user operation;

third control signal generator (600) arranged to generate a third brightness control signal (Vduty) in response to the first brightness control signal and the second brightness control signal from said first control signal

generator and said second control signal generator; and
an inverter (62) arranged to control the brightness of the backlight (60) in response to the third brightness control signal from said third control signal generator, wherein said third control signal generator includes:

a gating circuit arranged to selectively output the second brightness control signal generated from said second control signal generator when the first brightness control signal generated from said first control signal generator is a high level; and
an R-C circuit (500) arranged to accumulate the second brightness control signal outputted selectively from the gating circuit to generate the third brightness control signal,
wherein the accumulation in the capacitor of the R-C circuit (500) of the selectively output second brightness control signal over one frame of said corresponding image generates an analog signal that is the third brightness control signal.

2. The apparatus for automatic brightness control according to claim 1, wherein said first control signal generator is one selected from a timing controller (400), a graphic controller, and a LCD panel (10), and said second control signal generator is a computer (200).

3. The apparatus for automatic brightness control according to claim 1, wherein said R-C circuit (500) includes:

a resistor (R1) connected between said first control signal generator and said inverter (62); and
a capacitor (C1) connected between the resistor (R1) and ground.

4. The apparatus for automatic brightness control according to claim 1, wherein said gating circuit includes a transistor (T1) having one end connected through a first resistor (R3) to said first control signal generator, another end connected with said second control signal generator and the other end connected through a second resistor (R2) to ground.

5. The apparatus for automatic brightness control according to claim 4, wherein the transistor is one selected from an N-type transistor and a P-type transistor.

6. The apparatus for automatic brightness control according to claim 4, wherein the transistor (T1) can be a circuit element such as a calculation amplifier.

7. The apparatus for automatic brightness control according to claim 5, further including a level shift circuit (700) for swinging the transistor (T1) fully by lowering a voltage level of the first brightness control signal outputted from said first control signal generator as much as a given level when the transistor (T1) is a P-type transistor.

8. The apparatus for automatic brightness control according to claim 7, wherein the level shift circuit (700) includes:

a transistor (T3) having a current passage connected in serial between a power source (VDD) arranged to supply voltage and said third control signal generator, and a control end connected to said first control signal generator;
a third resistor (R9) having one end connected to the current passage of said transistor (T3) on the side of the third control signal generator;
a diode (D1) connected between the other end of said third resistor (R9) and the ground; and
a fourth resistor (R10) connected between the other end of said third resistor (R9) and a turn-off voltage.

9. The apparatus for automatic brightness control according to claim 1, wherein the third brightness control signal forming a variable brightness control voltage satisfies the following formula:

$$Vduty=\{Vo+(Vc-Vo)x\ [1-EXP[-T1/(R\ x\ C)]]\}x\ EXP[(T1-1H)/(R\ x\ C)]$$

10. The apparatus for automatic brightness control according to claim 1, wherein said first control signal generator further includes a function that determines a color state of the image data and then make the first brightness control signal to have a duty rate for controlling the brightness of the backlight (60) corresponding to the determined color state, wherein the color state is provided as 6 bit data that corresponds to 64 gray levels of white through black.

11. The apparatus for automatic brightness control according to claim 10, wherein said duty rate of said first brightness control signal is reduced in order of green, red, and blue when the determined color state is green, red, and blue.

12. The apparatus for automatic brightness control according to claim 11, wherein the duty rate of the first brightness control signal is set to have a rate of green : red : blue = 1 : 0.66 : 0.49 when the determined color state is green, red, and blue.

13. The apparatus for automatic brightness control according to claim 11, wherein said first control signal generator is a timing controller (400).

14. The apparatus for automatic brightness control according to claim 11, wherein said first control signal generator includes:

a control unit (428) arranged to control various operations of said first control signal generator to determine the color state of the image data and to generate the first brightness control signal;
a pixel data acquisition and conversion unit (421) arranged to receive the image data and converting the image data according to the determined color state, under the control of said control unit (428);
a computing unit arranged to compute the converted data logically and outputting a certain data, under the control of said control unit (428);
a down-counter (426) arranged to down-count the certain data under the control of said control unit (428); and
a pulse generator (427) arranged to generate the first brightness control signal corresponding to an output signal of said down-counter (426),
wherein said control unit (428) controls generation of the first brightness control signal corresponding to the output signal of said down-counter (426) until the first brightness control signal comes to a logic low level.

15. A method for automatic brightness control for use in an LCD device (100), comprising the steps of:

calculating an average gray level of image data for one horizontal line period of the corresponding image, to be displayed on said LCD device (100), the image data being represented by a number of bits per pixel;
generating a first brightness control signal (DUTY) having a high level, a low level and a duty rate that is in proportion to the average gray level;
generating a second brightness control signal (CTL-V) generated from a main body of a computer (200) by a user;
generating a third brightness control signal (Vduty) in response to the first brightness control signal and the second brightness control signal; and
controlling a brightness of said backlight (60) in response to said third brightness control signal, wherein
the second brightness control signal is selectively output when the first brightness control signal is a high level; and
the selectively output second brightness control signal is accumulated over one frame of said corresponding image in a capacitor within an R-C circuit (500) to generate an analog signal that is the third brightness control signal.

Patentansprüche

1. Vorrichtung zur automatischen Helligkeitsregelung zur Verwendung in einer LCD-Vorrichtung (100) mit einer Hintergrundbeleuchtung (60), umfassend:

einen erste Steuersignalgenerator, der dafür eingerichtet ist, Bilddaten zu empfangen, die auf der LCD-Vorrichtung (100) angezeigt werden sollen, indem ein mittlerer Graupegel der Bilddaten für eine Horizontalzeilenperiode des entsprechenden Bildes berechnet wird, wobei die Bilddaten durch eine Anzahl von Bits pro Pixel dargestellt werden, und ein erstes Helligkeitssteuersignal (DUTY) mit einem Hochpegel, einem Niedrigpegel und einem Tastverhältnis erzeugt wird, das im richtigen Verhältnis zur mittleren Graustufe steht;
einen zweiten Steuersignalgenerator, der dafür eingerichtet ist, ein zweites Helligkeitssteuersignal (CTL_V) zu erzeugen, um die Helligkeit der Hintergrundbeleuchtung (60) durch Benutzerbedienung zu steuern;
einen dritten Steuersignalgenerator (600), der dafür eingerichtet ist, ein drittes Helligkeitssteuersignal (Vduty) als Antwort auf das erste Helligkeitssteuersignal und das zweite Helligkeitssteuersignal von dem ersten Steuersignalgenerator und dem zweiten Steuersignalgenerator zu erzeugen; und
einen Inverter (62), der dafür eingerichtet ist, die Helligkeit der Hintergrundbeleuchtung (60) als Antwort auf das dritte Helligkeitssteuersignal von dem dritten Steuersignalgenerator zu steuern, wobei der dritte Steuersignal-

generator aufweist:

eine Gatterschaltung, die dafür eingerichtet ist, das zweite Helligkeitssteuersignal, das von dem zweiten Steuersignalgenerator erzeugt wird, selektiv ausgegeben, wenn das erste Helligkeitssteuersignal, das von dem ersten Steuersignalgenerator erzeugt wird, ein Hochpegel ist; und
eine RC-Schaltung (500), die dafür eingerichtet ist, das zweite Helligkeitssteuersignal, das von der Gatterschaltung selektiv ausgegeben wird, zu akkumulieren, um das dritte Helligkeitssteuersignal zu erzeugen, wobei die im Kondensator der RC-Schaltung (500) erfolgende Akkumulation des selektiv ausgegebenen zweiten Helligkeitssteuersignals über ein Teilbild des entsprechenden Bildes ein analoges Signal erzeugt, das das dritte Helligkeitssteuersignal ist.

2. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 1, wobei der erste Steuersignalgenerator einer ist, der aus Folgendem ausgewählt ist, nämlich einer Zeitsteuereinrichtung (400), eine Grafiksteuereinrichtung und eines LCD-Feldes (10) und der zweite Steuersignalgenerator ein Computer (200) ist.

3. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 1, wobei die RC-Schaltung (500) aufweist:

einen Widerstand (R1), der zwischen den ersten Steuersignalgenerator und den Inverter (62) geschaltet ist; und einen Kondensator (C1), der zwischen den Widerstand (R1) und Masse geschaltet ist.

4. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 1, wobei die Gatterschaltung einen Transistor (T1) aufweist, bei dem ein Ende über einen ersten Widerstand (R3) mit dem ersten Steuersignalgenerator verbunden ist, ein anderes Ende mit dem zweiten Steuersignalgenerator verbunden ist und das andere Ende über einen zweiten Widerstand (R2) mit Masse verbunden ist.

5. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 4, wobei der Transistor einer ist, der aus Folgendem ausgewählt ist, nämlich einem n-Transistor und einem p-Transistor.

6. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 4, wobei der Transistor (T1) ein Schaltelement sein kann, wie etwa ein Rechenverstärker.

7. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 5, ferner mit einer Pegelverschiebungsschaltung (700) zum vollen Ausschwingen des Transistors (T1) durch Absenken eines Spannungspegels des ersten Helligkeitssteuersignals, das von dem ersten Steuersignalgenerator ausgegeben wird, bis zu einem gegebenen Pegel, wenn der Transistor (T1) ein p-Transistor ist.

8. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 7, wobei die Pegelverschiebungsschaltung (700) aufweist:

einen Transistor (T3), dessen Stromdurchgang in Reihe zwischen eine Stromquelle (VDD), die dafür eingerichtet ist, Spannung zu liefern, und den dritten Steuersignalgenerator geschaltet ist und dessen Steuerende mit dem ersten Steuersignalgenerator verbunden ist
einen dritten Widerstand (R9), dessen eines Ende mit dem Stromdurchgang des Transistors (T3) auf der Seite des dritten Steuersignalgenerators verbunden ist;
eine Diode (D1), die zwischen das andere Ende des dritten Widerstands (R9) und Masse geschaltet ist; und
einen vierten Widerstand (R10), der zwischen das andere Ende des dritten Widerstands (R9) und eine Abschaltspannung geschaltet ist

9. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 1, wobei das dritte Helligkeitssteuersignal, das eine variable Helligkeitssteuerspannung bildet, die folgende Formel erfüllt:

$$Vduty = \{Vo + (VC\text{-}Vo) \times [1\text{-}EXP\ [-T1 / (R \times C)]]\} \times EXP\ [(T1\text{-}1H) / (R \times C)]$$

10. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 1, wobei der erste Steuersignalgenerator ferner eine Funktion aufweist, die einen Farbzustand der Bilddaten bestimmt und dann bewirkt, dass das erste Helligkeitssteuersignal ein Tastverhältnis zur Steuerung der Helligkeit der Hintergrundbeleuchtung (60) entsprechend dem

bestimmten Farbzustand hat, wobei der Farbzustand als 6-Bit-Daten, die 64 Graustufen von Weiß bis Schwarz entsprechen, bereitgestellt wird.

11. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 10, wobei das Tastverhältnis des ersten Helligkeitssteuersignals in der Reihenfolge Grün, Rot und Blau reduziert wird, wenn der bestimmte Farbzustand ist Grün, Rot und Blau ist.

12. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 11, wobei das Tastverhältnis des ersten Helligkeitssteuersignals so eingestellt wird, dass es ein Grün-Rot-Blau-Verhältnis = 1 : 0,66 : 0,49 hat, wenn der bestimmte Farbzustand Grün, Rot und Blau ist.

13. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 11, wobei der erste Steuersignalgenerator eine Zeitsteuereinrichtung (400) ist.

14. Vorrichtung zur automatischen Helligkeitsregelung nach Anspruch 11, wobei der erste Steuersignalgenerator aufweist:

eine Steuereinheit (428), die dafür eingerichtet ist, verschiedene Operationen des ersten Steuersignalgenerators zu steuern, um den Farbzustand der Bilddaten zu bestimmen und das erste Helligkeitssteuersignal zu erzeugen;
eine Pixeldatenerfassungs- und Konvertierungseinheit (421), die dafür eingerichtet ist, die Bilddaten zu empfangen und die Bilddaten gemäß dem bestimmten Farbzustand unter der Steuerung der Steuereinheit (428) zu konvertieren;
eine Recheneinheit, die dafür eingerichtet ist, die konvertierten Daten logisch zu errechnen und bestimmte Daten unter der Steuerung der Steuereinheit (428) auszugeben;
einen Rückwärtszähler (426), der dafür eingerichtet ist, die bestimmte Daten unter der Steuerung der Steuereinheit (428) rückwärts zu zählen; und
einen Impulsgenerator (427), der dafür eingerichtet ist, das erste Helligkeitssteuersignals entsprechend einem Ausgangssignal des Rückwärtszählers (426) zu erzeugen,
wobei die Steuereinheit (428) die Erzeugung des ersten Helligkeitssteuersignals entsprechend dem Ausgangssignal des Rückwärtszählers (426) steuert, bis das erste Helligkeitssteuersignal auf einen logischen Tiefpegel geht.

15. Verfahren zur automatischen Helligkeitsregelung zur Verwendung in einer LCD-Vorrichtung (100), umfassend die Schritte:

Berechnen eines mittleren Graupegels von Bilddaten für eine Horizontalzeilenperiode des entsprechenden Bildes, das auf der LCD-Vorrichtung (100) angezeigt werden soll, wobei die Bilddaten durch eine Anzahl von Bits pro Pixel dargestellt werden;
Erzeugen eines ersten Helligkeitssteuersignals (DUTY) mit einem Hochpegel, einem Niedrigpegel und einem Tastverhältnis, das im richtigen Verhältnis zur mittleren Graustufe steht;
Erzeugen eines zweiten Helligkeitssteuersignals (CLT_V), das von einem Hauptkörper eines Computers (200) durch einen Benutzer erzeugt wird;
Erzeugen eines dritten Helligkeitssteuersignals (Vduty) als Antwort auf das erste Helligkeitssteuersignal und das zweite Helligkeitssteuersignal; und
Steuern einer Helligkeit der Hintergrundbeleuchtung (60) als Antwort auf das dritte Helligkeitssteuersignal, wobei das zweite Helligkeitssteuersignal selektiv ausgegeben wird, wenn das erste Helligkeitssteuersignal ein Hochpegel ist; und
das selektiv ausgegebene zweite Helligkeitssteuersignal über ein Teilbild des entsprechenden Bildes in einem Kondensator in einer RC-Schaltung (500) akkumuliert wird, um ein analoges Signal zu erzeugen, das das dritte Helligkeitssteuersignal ist.

Revendications

1. Appareil permettant une commande automatique de luminosité pour une utilisation dans un dispositif LCD (100) présentant un éclairage arrière (60), comprenant :

un premier générateur de signal de commande agencé pour recevoir des données d'images à afficher sur le

dispositif LCD (100), calculant un niveau moyen de gris des données d'images pour une période de ligne horizontale de l'image correspondante, les données d'images étant représentées par un nombre de bits par pixel, et générant un premier signal de commande de luminosité (DUTY) présentant un niveau élevé, un niveau bas et une vitesse de service qui est en proportion du niveau moyen de gris ;

un deuxième générateur de signal de commande agencé pour générer un deuxième signal de commande de luminosité (CTL_V) afin de commander la luminosité de l'éclairage arrière (60) par action de l'utilisateur ;

un troisième générateur de signal de commande (600) agencé pour générer un troisième signal de commande de luminosité (Vduty) en réaction au premier signal de commande de luminosité et au deuxième signal de commande de luminosité provenant dudit premier générateur de signal de commande et dudit deuxième générateur de signal de commande ; et

un convertisseur (62) agencé pour commander la luminosité de l'éclairage arrière (60) en réaction au troisième signal de commande de luminosité provenant dudit troisième générateur de signal de commande, dans lequel ledit troisième générateur de signal de commande comprend :

un circuit de portillonnage agencé pour produire de manière sélective le deuxième signal de commande de luminosité généré à partir dudit deuxième générateur de signal de commande lorsque le premier signal de commande de luminosité généré à partir dudit premier générateur de signal de commande est à un niveau élevé ; et

un circuit résistance-condensateur R-C (500) agencé pour accumuler le deuxième signal de commande de luminosité produit de manière sélective à partir du circuit de portillonnage afin de générer le troisième signal de commande de luminosité,

dans lequel l'accumulation dans le condensateur du circuit R-C (500) du deuxième signal de commande de luminosité produit de manière sélective sur une vue de ladite image correspondante génère un signal analogique qui constitue le troisième signal de commande de luminosité.

2. Appareil permettant une commande automatique de luminosité selon la revendication 1, dans lequel ledit premier générateur de signal de commande est sélectionné parmi un contrôleur de temporisation (400), un contrôleur de graphique, et un panneau LCD (10), et ledit deuxième générateur de signal de commande est un ordinateur (200).

3. Appareil permettant une commande automatique de luminosité selon la revendication 1, dans lequel ledit circuit R-C (500) comprend :

une résistance (R1) connectée entre ledit premier générateur de signal de commande et ledit convertisseur (62) ; et

un condensateur (C1) connecté entre la résistance (R1) et la terre.

4. Appareil permettant une commande automatique de luminosité selon la revendication 1, dans lequel ledit circuit de portillonnage comprend un transistor (T1) présentant une extrémité connectée par l'intermédiaire d'une première résistance (R3) audit premier générateur de signal de commande, une autre extrémité connectée audit deuxième générateur de signal de commande, et l'autre extrémité connectée par l'intermédiaire d'une deuxième résistance (R2) à la terre.

5. Appareil permettant une commande automatique de luminosité selon la revendication 4, dans lequel le transistor est sélectionné parmi un transistor de type N et un transistor de type P.

6. Appareil permettant une commande automatique de luminosité selon la revendication 4, dans lequel le transistor (T1) peut-être un élément de circuit tel qu'un amplificateur de calcul.

7. Appareil permettant une commande automatique de luminosité selon la revendication 5, comprenant en outre un circuit de décalage de niveau (700) permettant de basculer complètement le transistor (T1) en abaissant un niveau de tension du premier signal de commande de luminosité produit à partir dudit premier générateur de signal de commande à hauteur d'un niveau donné lorsque le transistor (T1) est un transistor de type P.

8. Appareil permettant une commande automatique de luminosité selon la revendication 7, dans lequel le circuit de décalage de niveau (700) comprend :

un transistor (T3) présentant un passage de courant connecté en série entre une source d'énergie (VDD) agencée pour fournir une tension et ledit troisième générateur de signal de commande, et une extrémité de

commande connectée audit premier générateur de signal de commande ;
une troisième résistance (R9) présentant une extrémité connectée au passage de courant dudit transistor (T3) sur le côté du troisième générateur de signal de commande ;
une diode (D1) connectée entre l'autre extrémité de ladite troisième résistance (R9) et la terre ; et
une quatrième résistance (R10) connectée entre l'autre extrémité de ladite troisième résistance (R9) et une tension de coupure.

9. Appareil permettant une commande automatique de la luminosité selon la revendication 1, dans lequel le troisième signal de commande de luminosité formant une tension de commande de luminosité variable satisfait la formule suivante :

$$Vduty=\{Vo+(Vc-Vo)\times[1-EXP[-T1/(R\times C)]]\}\times EXP[(T1-1H)/(R\times C)]$$

10. Appareil permettant une commande automatique de luminosité selon la revendication 1, dans lequel ledit premier générateur de signal de commande comprend en outre une fonction qui détermine un état de couleur des données d'images et amène ensuite le premier signal de commande de luminosité à présenter une vitesse de service permettant de commander la luminosité de l'éclairage arrière (60) en fonction de l'état de couleur déterminée, dans lequel l'état de couleur est fourni sous forme de données 6 bits qui correspondent à 64 niveaux de gris allant du blanc ou noir.

11. Appareil permettant une commande automatique de luminosité selon la revendication 10, dans lequel ladite vitesse de service dudit premier signal de commande de luminosité est réduite dans un ordre vert, rouge, et bleu lorsque l'état de couleur déterminé est vert, rouge, et bleu.

12. Appareil permettant une commande automatique de luminosité selon la revendication 11, dans lequel la vitesse de service du premier signal de commande de luminosité est ajustée afin de présenter un taux de vert : rouge : bleu = 1 : 0,66 : 0,49 lorsque l'état de couleur déterminé est vert, rouge, et bleu.

13. Appareil permettant une commande automatique de la luminosité selon la revendication 11, dans lequel ledit premier générateur de signal de commande est un contrôleur de temporisation (400).

14. Appareil permettant une commande automatique de luminosité selon la revendication 11, dans lequel ledit premier générateur de signal de commande comprend :

une unité de commande (428) agencée pour commander diverses actions dudit premier générateur de signal de commande afin de déterminer l'état de couleur des données d'images et de générer le premier signal de commande de luminosité ;
une unité d'acquisition et de conversion de données de pixels (421) agencée pour recevoir les données d'images et convertir les données d'images en fonction de l'état de couleur déterminée, sous le contrôle de ladite unité de commande (428) ;
une unité de calcul agencée pour calculer les données converties de manière logique et produire certaines données, sous le contrôle de ladite unité de commande (428) ;
un décompteur (426) agencé pour décompter les certaines données sous le contrôle de ladite unité de commande (428) ;
un générateur d'impulsions (427) agencé pour générer le premier signal de commande de luminosité en fonction d'un signal de sortie dudit décompteur (426),
dans lequel ladite unité de commande (428) commande une génération du premier signal de commande de luminosité en fonction du signal de sortie dudit décompteur (426) jusqu'à ce que le premier signal de commande de luminosité parvienne à un niveau logique bas.

15. Procédé permettant une commande automatique de la luminosité pour une utilisation dans un dispositif LCD (100), comprenant les étapes consistant à :

calculer un niveau moyen de gris de données d'images pour une période de ligne horizontale de l'image correspondante, à afficher sur ledit dispositif LCD (100), les données d'images étant représentées par un nombre de bits par pixel ;

générer un premier signal de commande de luminosité (DUTY) présentant un niveau élevé, un niveau bas et une vitesse de service qui est en proportion du niveau moyen de gris ;
générer un deuxième signal de commande de luminosité (CTL_V) généré à partir d'un élément principal d'un ordinateur (200) par un utilisateur ;
générer un troisième signal de commande de luminosité (Vduty) en réaction au premier signal de commande de luminosité et au deuxième signal de commande de luminosité ; et
commander une luminosité dudit éclairage arrière (60) en réaction audit troisième signal de commande de luminosité, dans lequel
le deuxième signal de commande de luminosité est produit de manière sélective lorsque le premier signal de commande de luminosité est à un niveau élevé ; et
le deuxième signal de commande de luminosité produit de manière sélective est accumulé sur une vue de ladite image correspondante dans un condensateur au sein d'un circuit R-C (500) afin de générer un signal analogique qui constitue le troisième signal de commande de luminosité.

Fig. 1

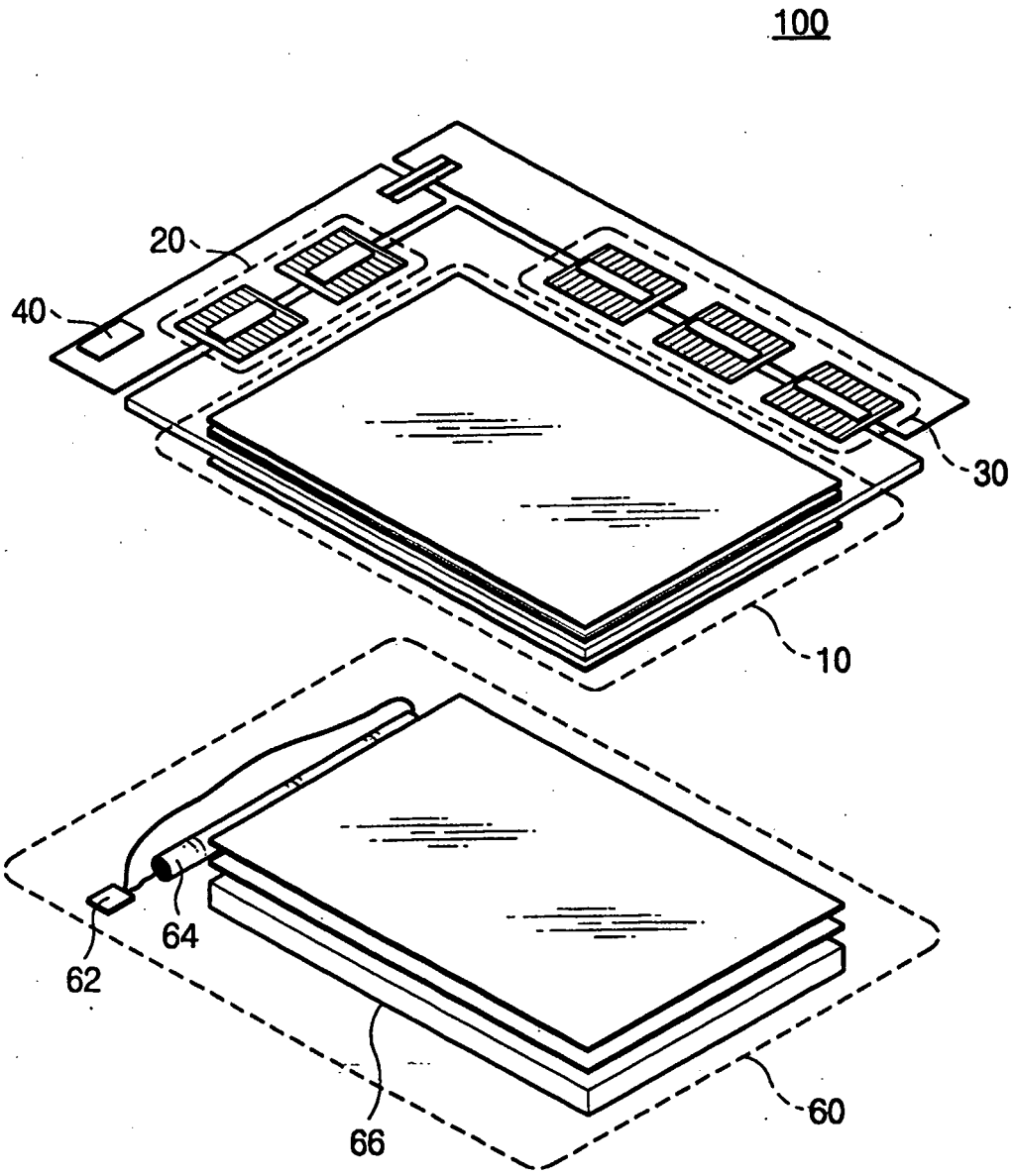


Fig. 2

(Prior Art)

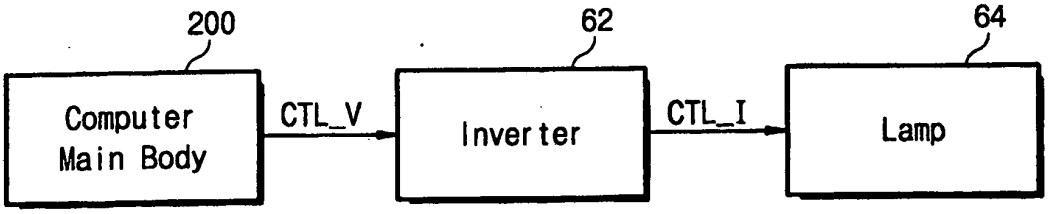


Fig. 3

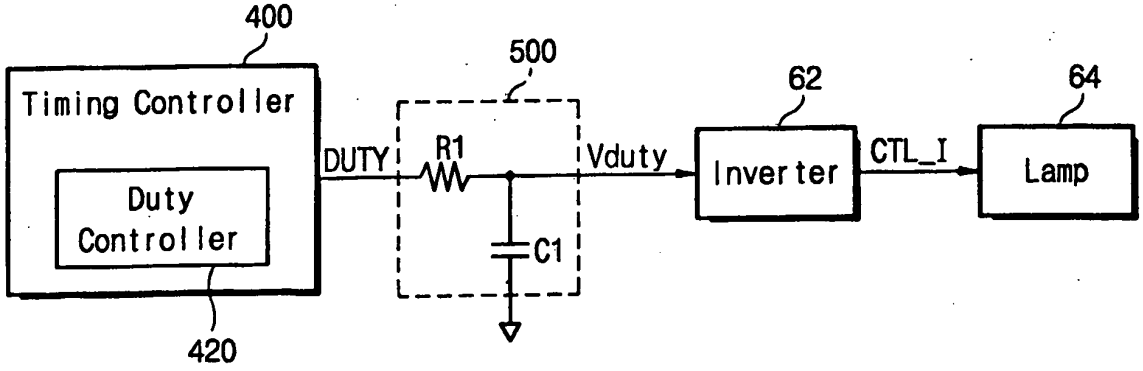


Fig. 4

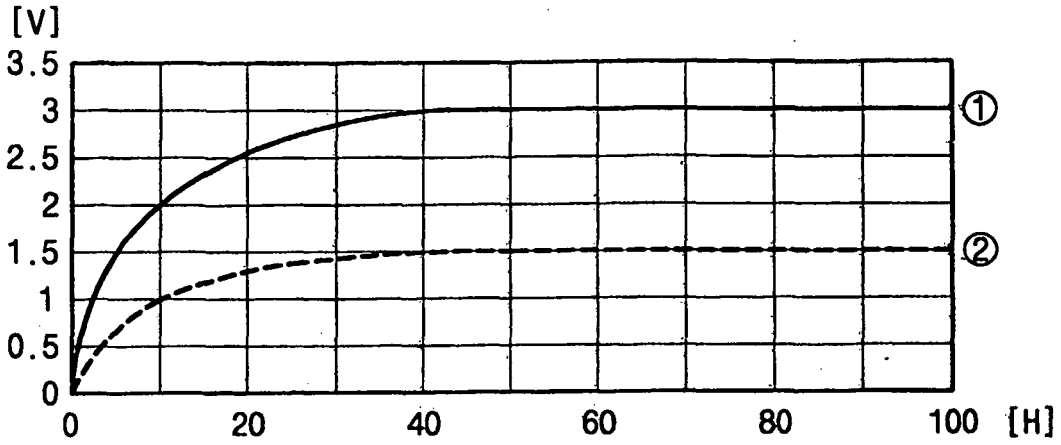


Fig. 5

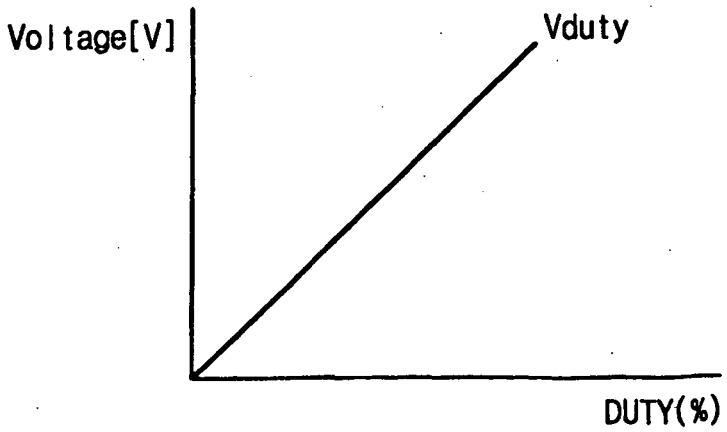


Fig. 6

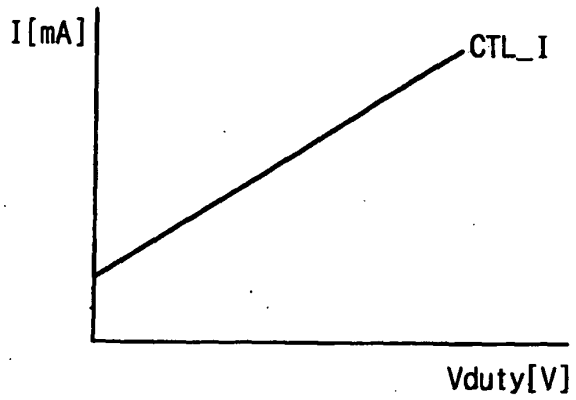

I[mA]
CTL_I
Vduty[V]

Fig. 7

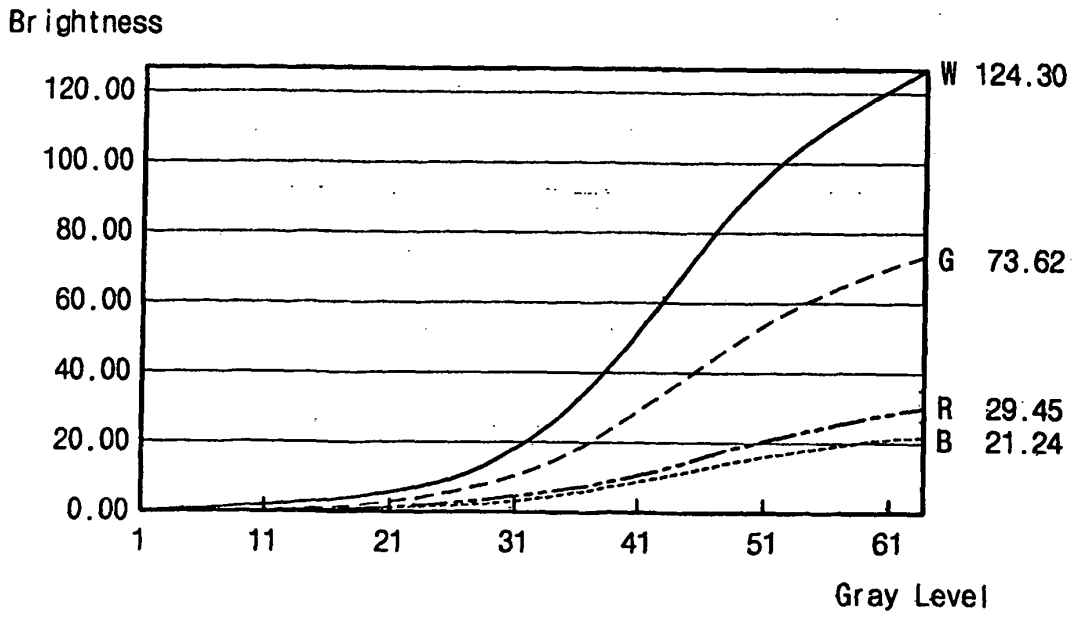

Brightness
120.00
100.00
80.00
60.00
40.00
20.00
0.00
1
11
21
31
41
51
61
Gray Level
W 124.30
G 73.62
R 29.45
B 21.24

Fig. 8

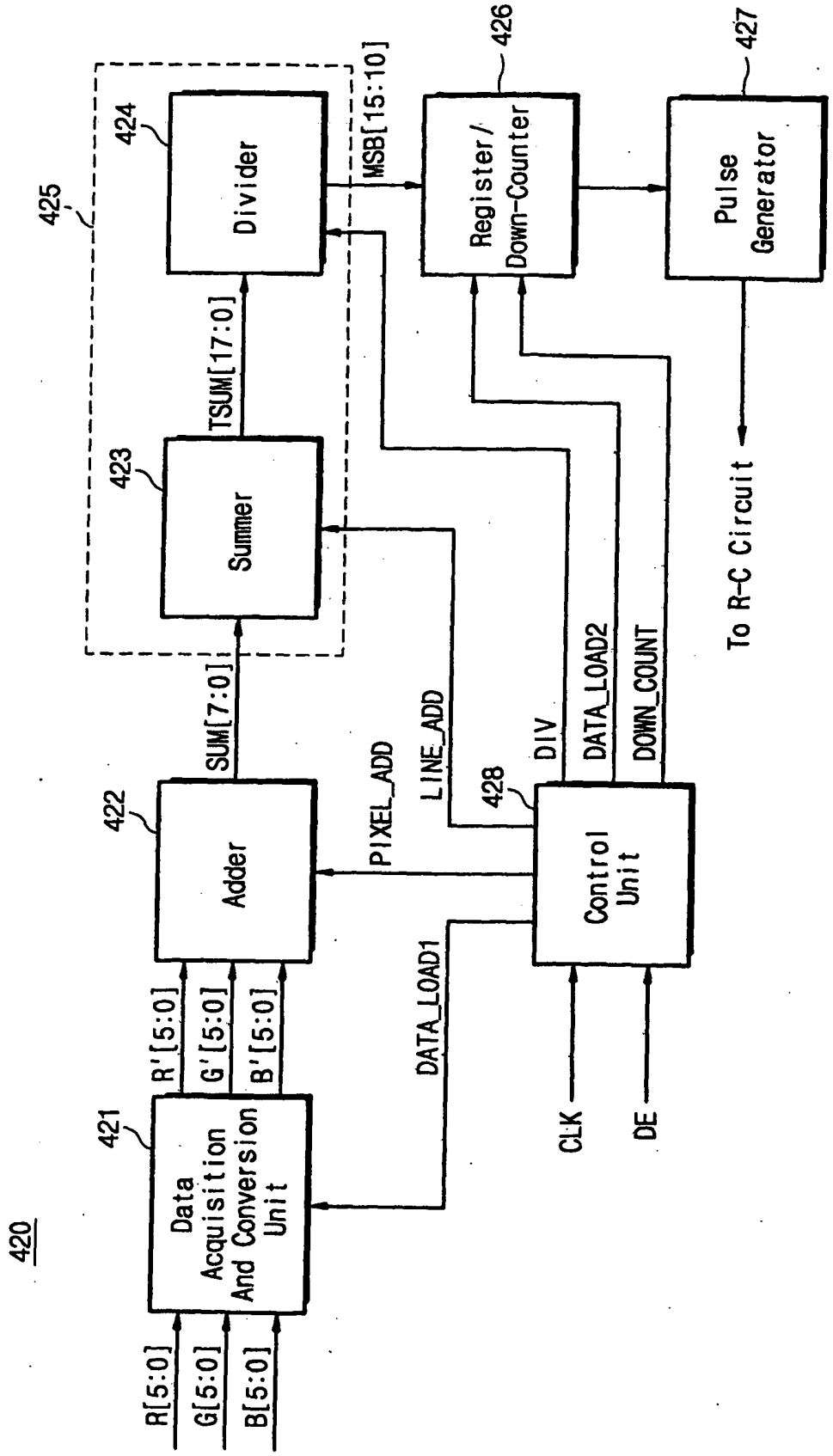

420
421
Data Acquisition And Conversion Unit
422
Adder
423
Summer
424
Divider
425
426
Register/ Down-Counter
427
Pulse Generator
428
Control Unit
R[5:0]
G[5:0]
B[5:0]
R'[5:0]
G'[5:0]
B'[5:0]
SUM[7:0]
TSUM[17:0]
MSB[15:10]
DATA_LOAD1
PIXEL_ADD
LINE_ADD
DIV
DATA_LOAD2
DOWN_COUNT
CLK
DE
To R-C Circuit

Fig. 9

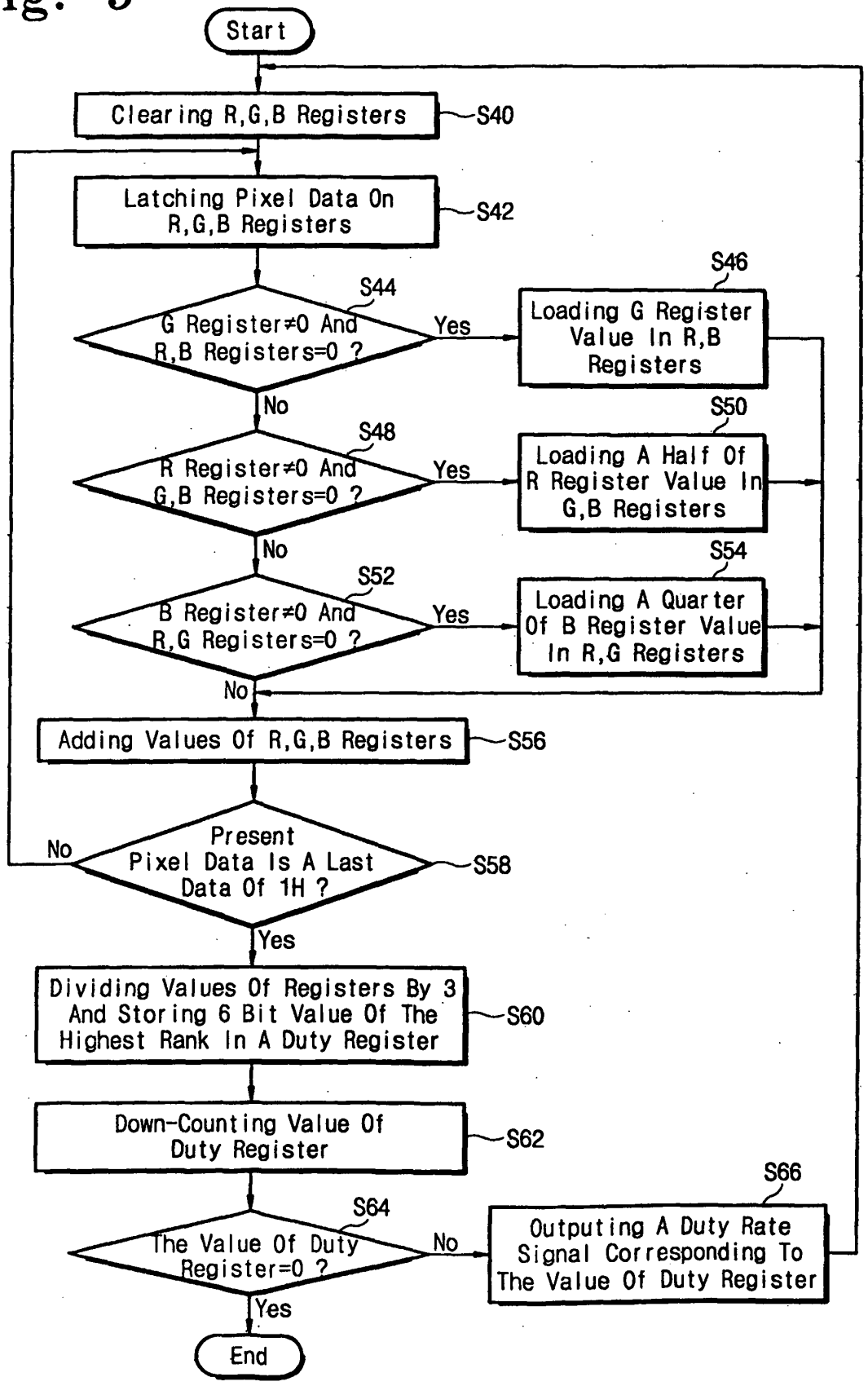

Start
Clearing R,G,B Registers
S40
Latching Pixel Data On R,G,B Registers
S42
S44
G Register≠0 And R,B Registers=0 ?
Yes
S46
Loading G Register Value In R,B Registers
No
S48
R Register≠0 And G,B Registers=0 ?
Yes
S50
Loading A Half Of R Register Value In G,B Registers
No
S52
B Register≠0 And R,G Registers=0 ?
Yes
S54
Loading A Quarter Of B Register Value In R,G Registers
No
Adding Values Of R,G,B Registers
S56
Present Pixel Data Is A Last Data Of 1H ?
S58
No
Yes
Dividing Values Of Registers By 3 And Storing 6 Bit Value Of The Highest Rank In A Duty Register
S60
Down-Counting Value Of Duty Register
S62
S64
The Value Of Duty Register=0 ?
No
S66
Outputing A Duty Rate Signal Corresponding To The Value Of Duty Register
Yes
End

Fig. 10

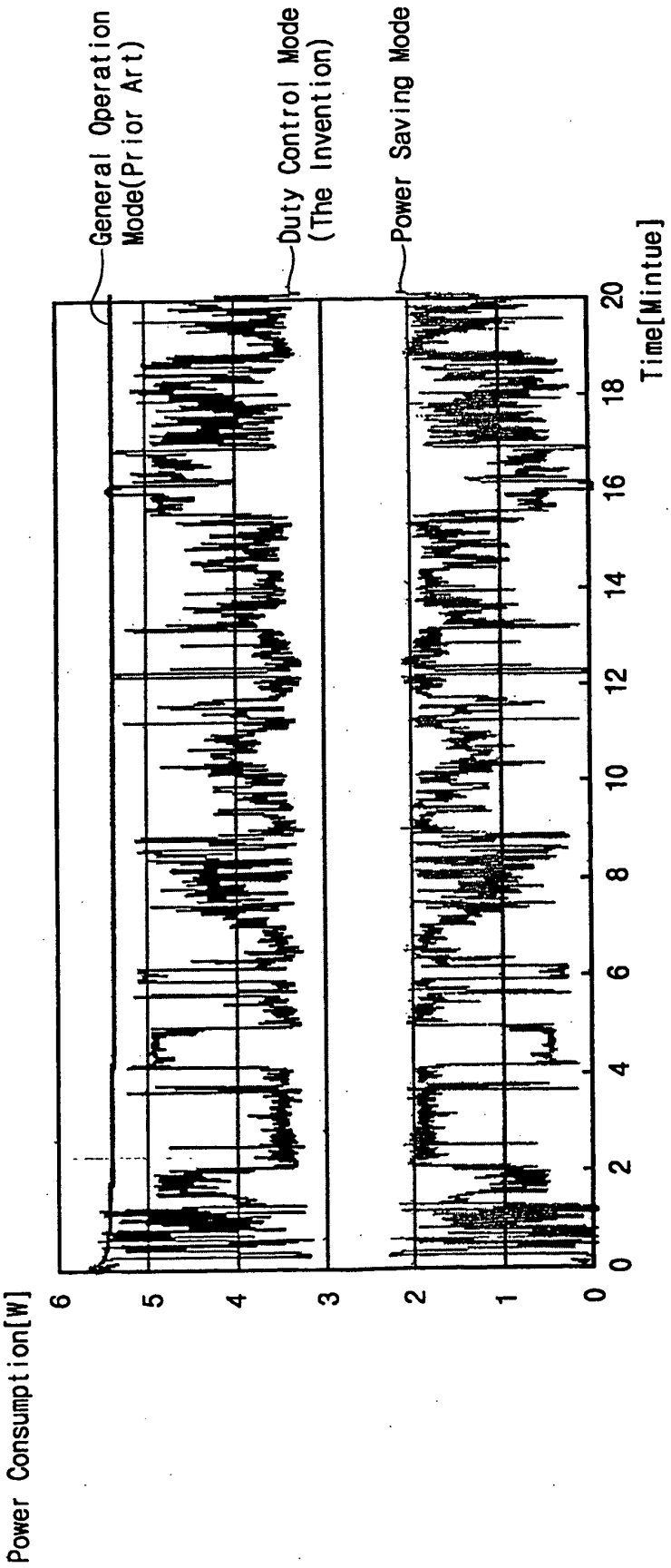

General Operation Mode(Prior Art)
Duty Control Mode (The Invention)
Power Saving Mode
Power Consumption[W]
Time[Mintue]
0
1
2
3
4
5
6
0
2
4
6
8
10
12
14
16
18
20

Fig. 11

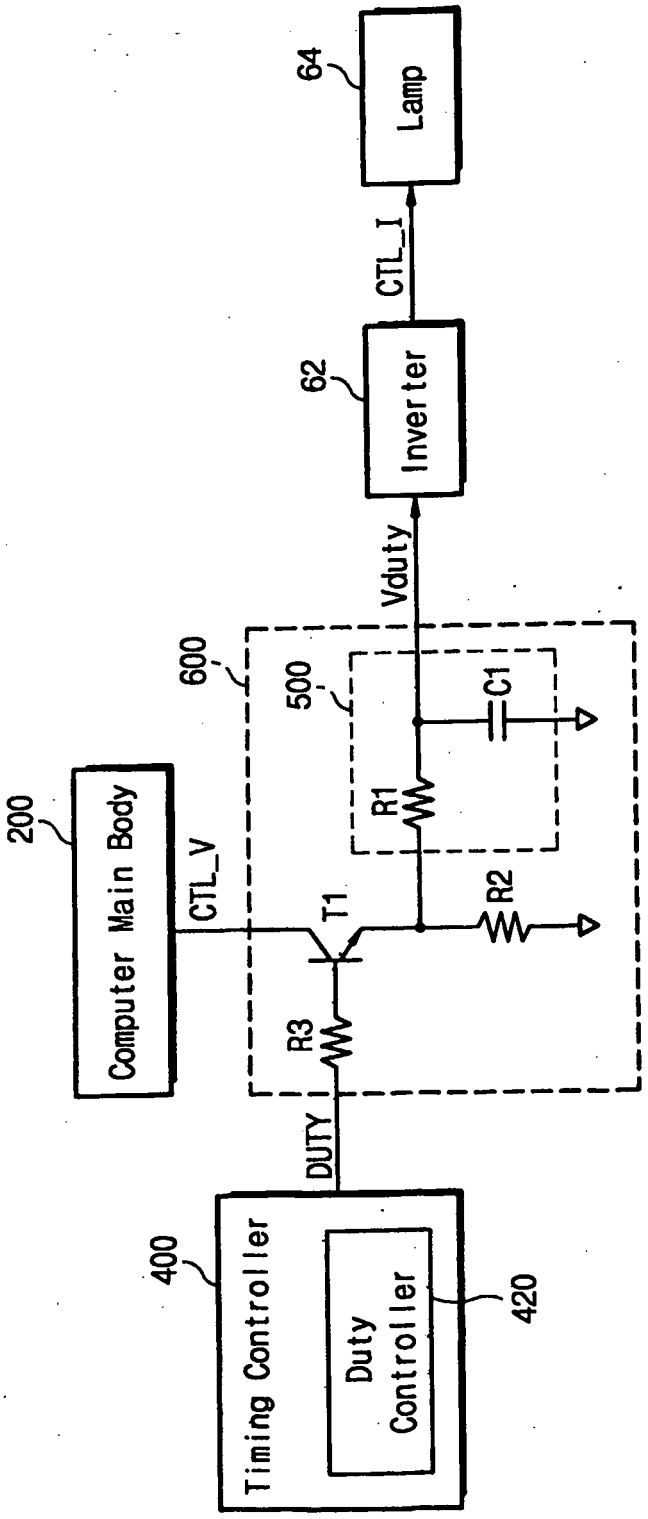

64
Lamp
CTL_I
62
Inverter
Vduty
600
500
C1
R1
R2
200
Computer Main Body
CTL_V
T1
R3
DUTY
400
Timing Controller
Duty Controller
420

Fig. 12

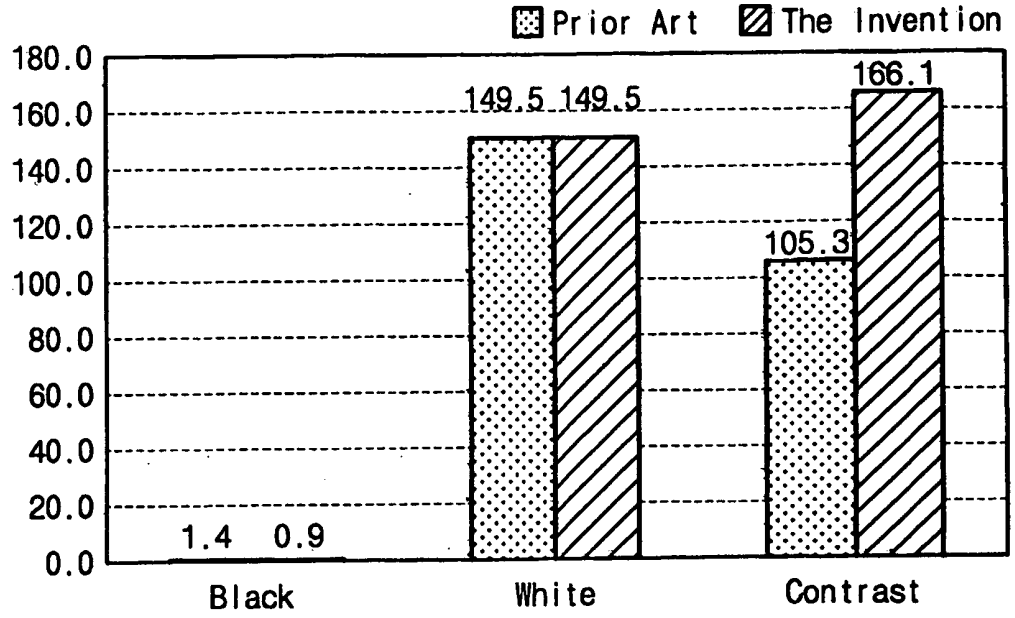

Prior Art
The Invention
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1.4
0.9
149.5
149.5
105.3
166.1
Black
White
Contrast

Fig. 13

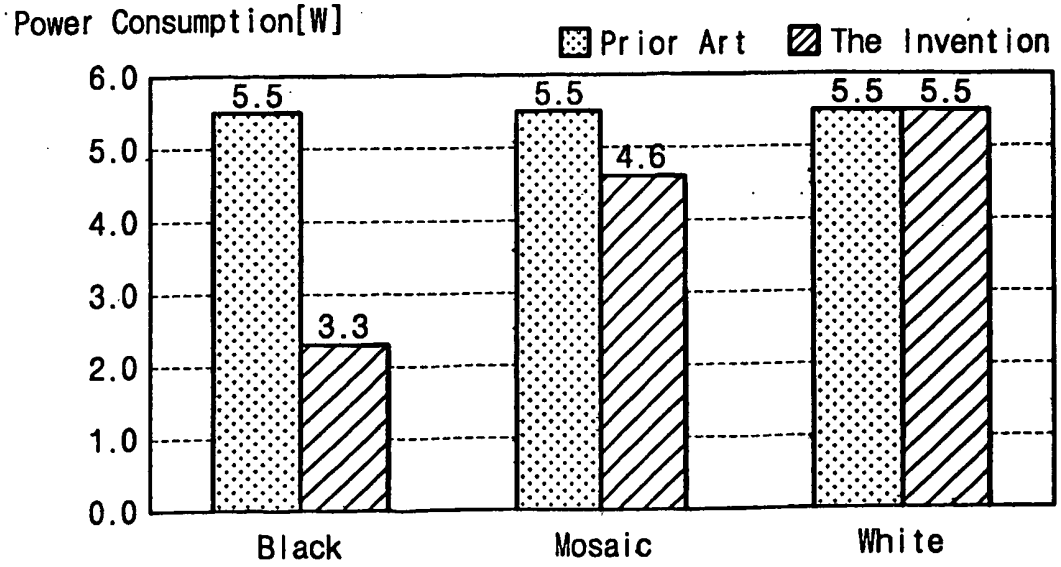

Power Consumption[W]
Prior Art
The Invention
6.0
5.0
4.0
3.0
2.0
1.0
0.0
5.5
3.3
5.5
4.6
5.5
5.5
Black
Mosaic
White

Fig. 14

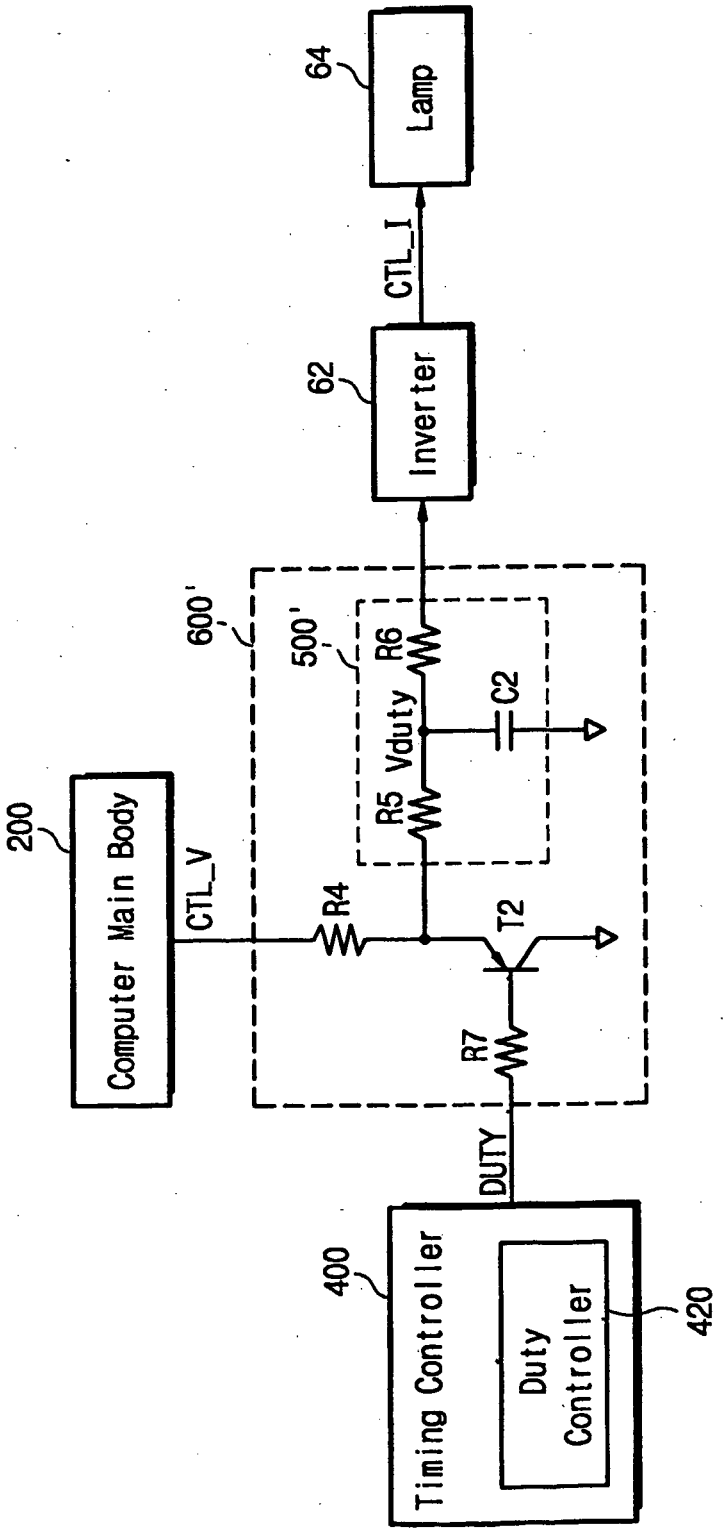

64
Lamp
CTL_I
62
Inverter
600'
500'
R6
C2
Vduty
R5
200
Computer Main Body
CTL_V
R4
T2
R7
DUTY
400
Timing Controller
Duty Controller
420

Fig. 15

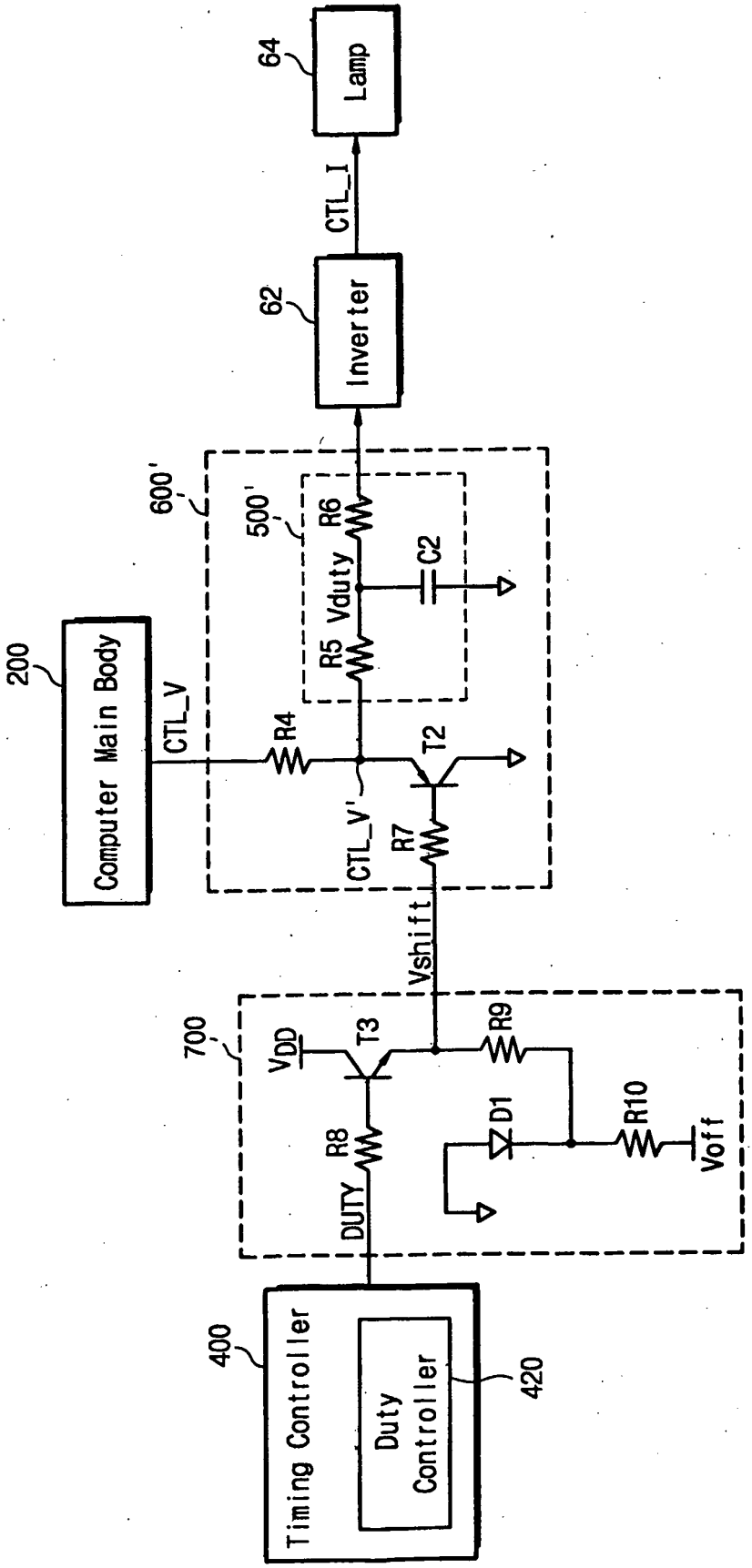

64
Lamp
CTL_I
62
Inverter
600'
500'
R6
Vduty
C2
R5
200
Computer Main Body
CTL_V
R4
T2
CTL_V'
R7
Vshift
700
VDD
T3
R9
R8
D1
R10
Voff
DUTY
400
Timing Controller
Duty Controller
420

Fig. 16

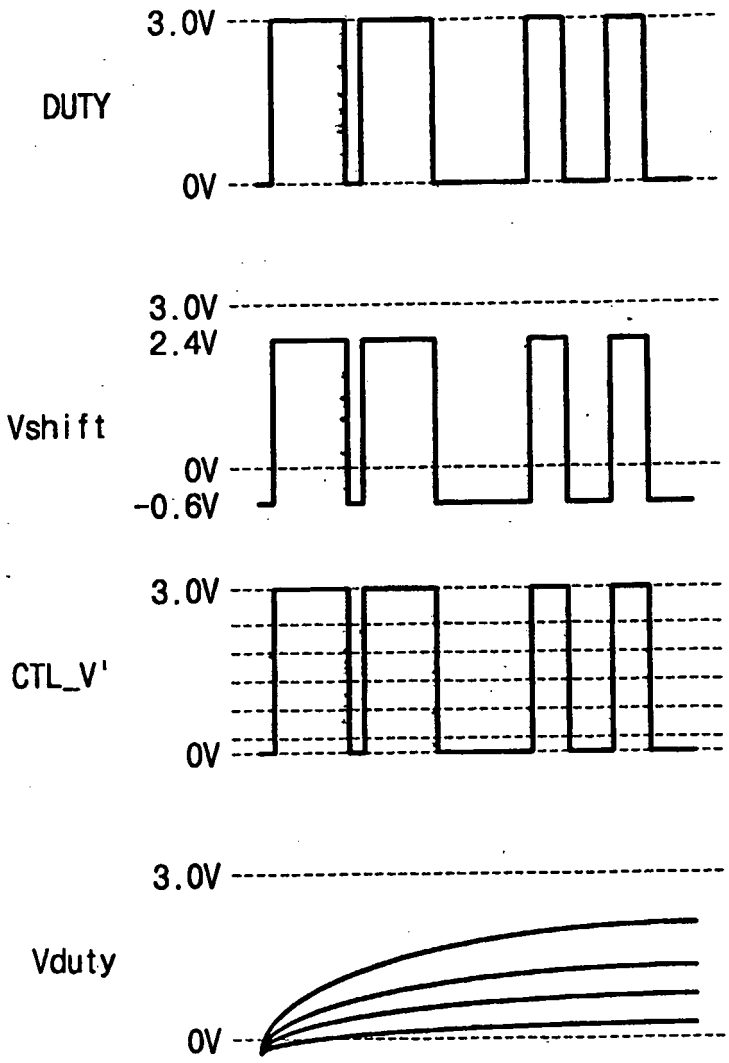
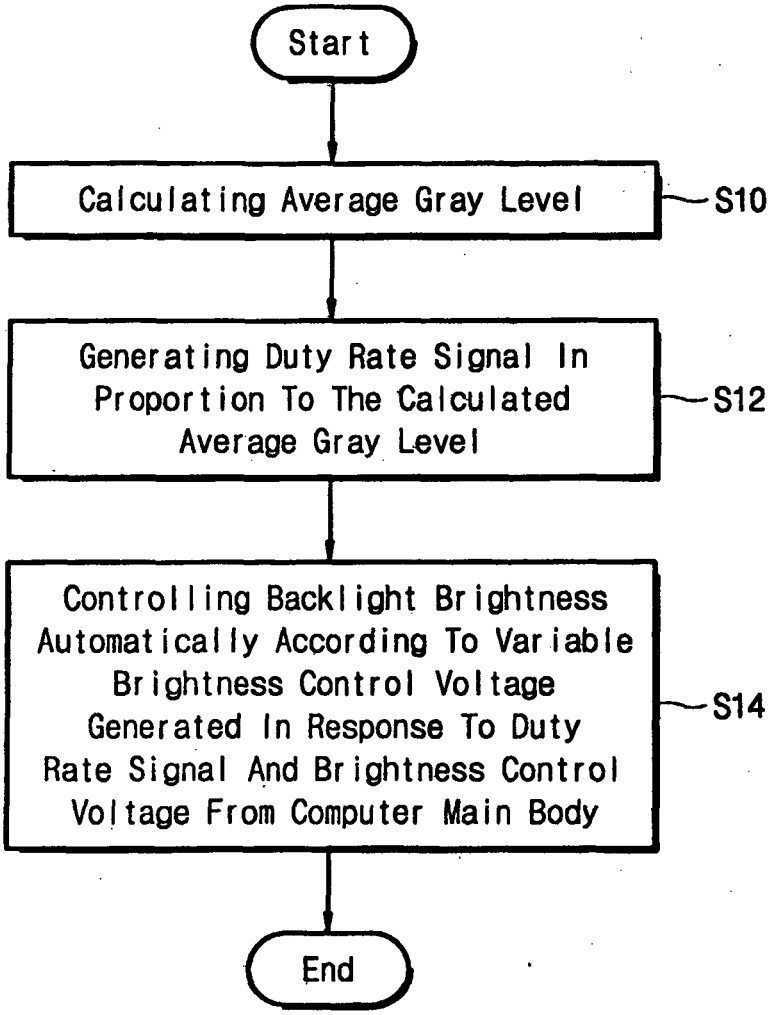


Fig. 17


Start
Calculating Average Gray Level
S10
Generating Duty Rate Signal In Proportion To The Calculated Average Gray Level
S12
Controlling Backlight Brightness Automatically According To Variable Brightness Control Voltage Generated In Response To Duty Rate Signal And Brightness Control Voltage From Computer Main Body
S14
End

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 5717422 A **[0007]**
- WO 9963515 A **[0008]**
- WO 0068926 A **[0009]**
- JP 55082375 B **[0010]**
- US 5057744 A **[0011]**

专利名称(译)	用于液晶显示装置的背光的自动亮度控制的装置和方法		
公开(公告)号	EP1223570B1	公开(公告)日	2014-10-08
申请号	EP2001309446	申请日	2001-11-07
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当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
[标]发明人	MOON SEUNG HWAN KIM SANG SOO PARK DONG WON CHOI HYEONG BAE		
发明人	MOON, SEUNG-HWAN KIM, SANG-SOO PARK, DONG-WON CHOI, HYEONG-BAE		
IPC分类号	G09G3/34 G02F1/133 G09G3/20 G09G3/36 H04N5/66 H05B41/40 H05B41/42		
CPC分类号	G09G3/3406 G09G3/2011 G09G3/3413 G09G2320/0238 G09G2320/0276 G09G2320/0606 G09G2320/0613 G09G2320/064 G09G2320/0653 G09G2330/021 G09G2360/16		
优先权	1020000085540 2000-12-29 KR 1020010026136 2001-05-14 KR		
其他公开文献	EP1223570A2 EP1223570A3		
外部链接	Espacenet		

摘要(译)

具有背光的LCD装置响应于与要在LCD装置上显示的图像数据的平均灰度级和/或颜色状态相对应的占空比信号以及从主装置产生的亮度控制电压而产生背光亮度控制信号。用户的身体，根据背光亮度控制信号自动控制背光的亮度。

[Mathematical formula 1]

$$Vduty=\{Vo+(Vc-Vo)x\ [1-EXP[-T1/(Rx\ C)]]\}x\ EXP\{(T1-1H)/(R\ x\ C)\}$$