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(54) **APPARATUS AND METHOD FOR LUMINANCE CONTROL OF LIQUID CRYSTAL DISPLAY DEVICE**

(76) Inventors: **Hee Jung Hong**, Seoul (KR); **Kyung Joon Kwon**, Seoul (KR)

Correspondence Address:
Song K. Jung
MCKENNA LONG & ALDRIDGE LLP
1900 K Street, N.W.
Washington, DC 20006 (US)

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(57) **ABSTRACT**

An apparatus and method for controlling luminance in an liquid crystal display device includes: a liquid crystal display panel having at least two designated areas; at least two lamp units irradiating light the designated areas of the liquid crystal display panel; an arithmetic unit configured to scan image pixels within each of the designated areas of the liquid crystal display panel, to extract a peak value of the gray level of pixels, and to calculate an average peak value for each designated area; and a lamp driver configured to control the lamp units, irradiating light to each designated area, based on the average peak value.

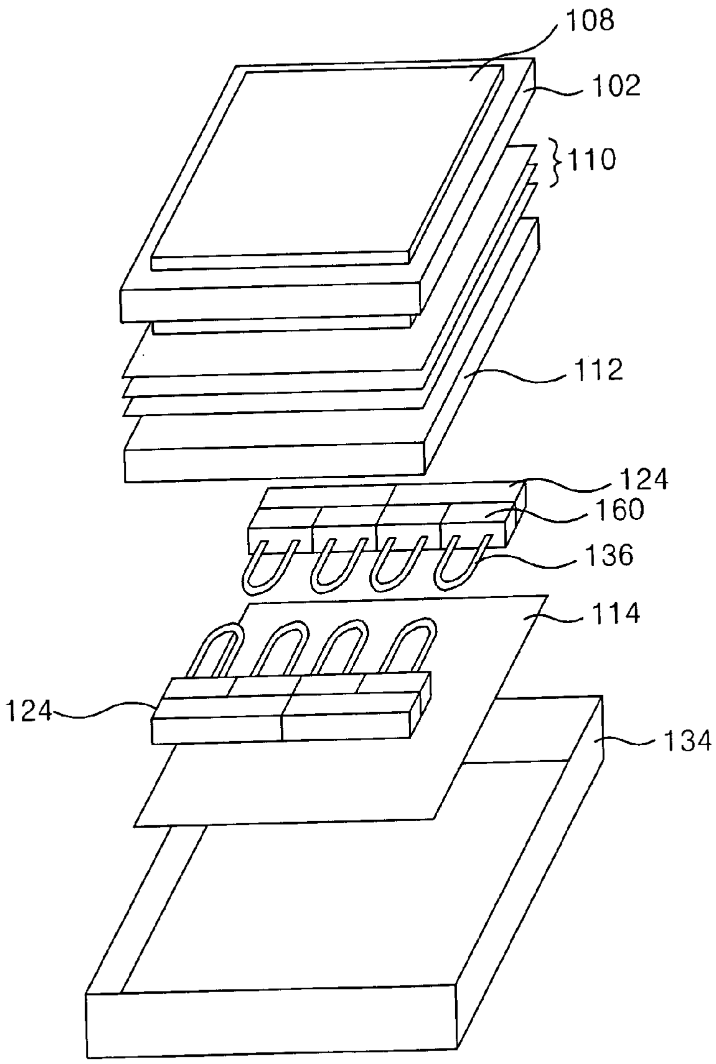


FIG. 1
RELATED ART

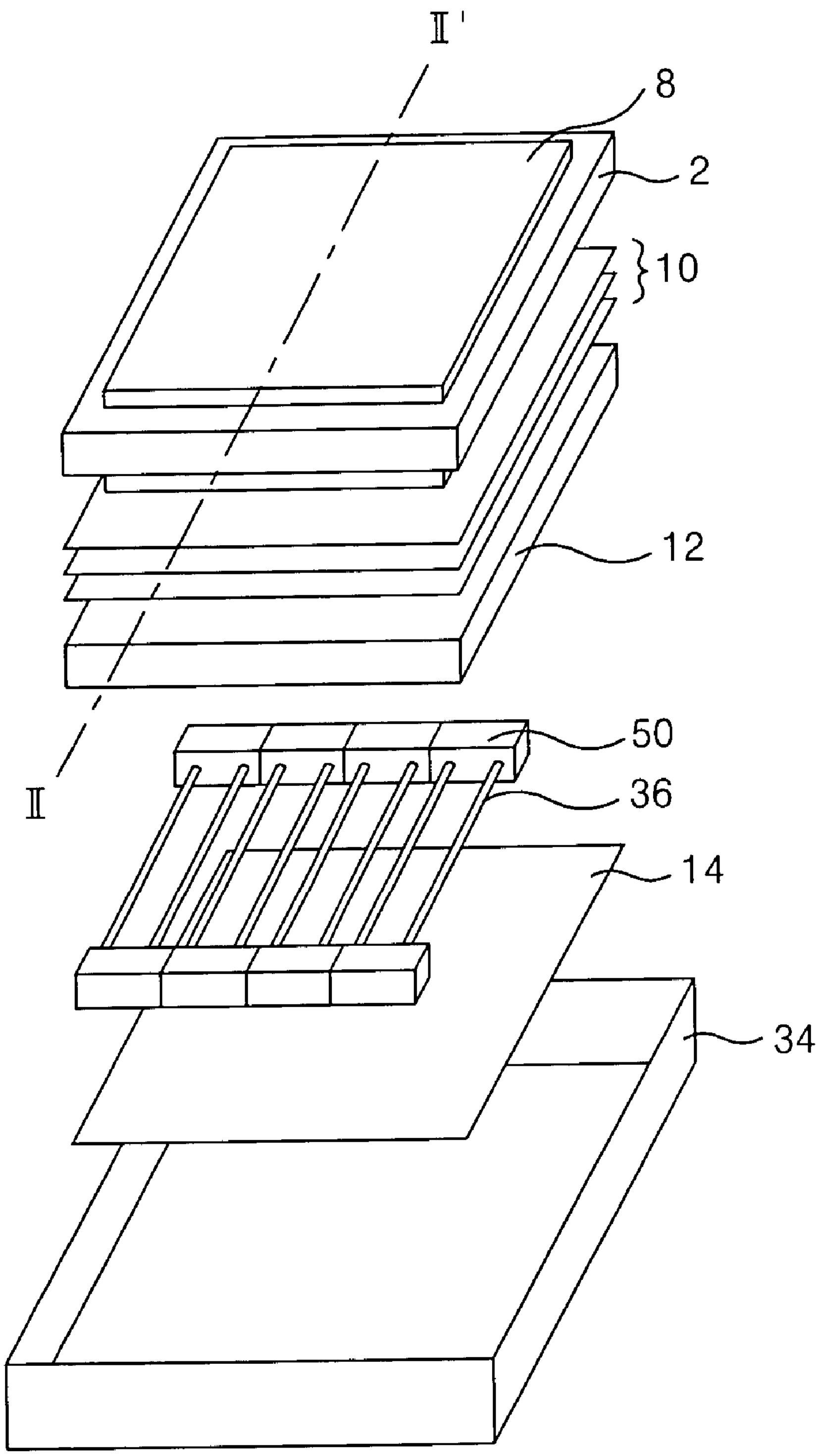


FIG. 2
RELATED ART

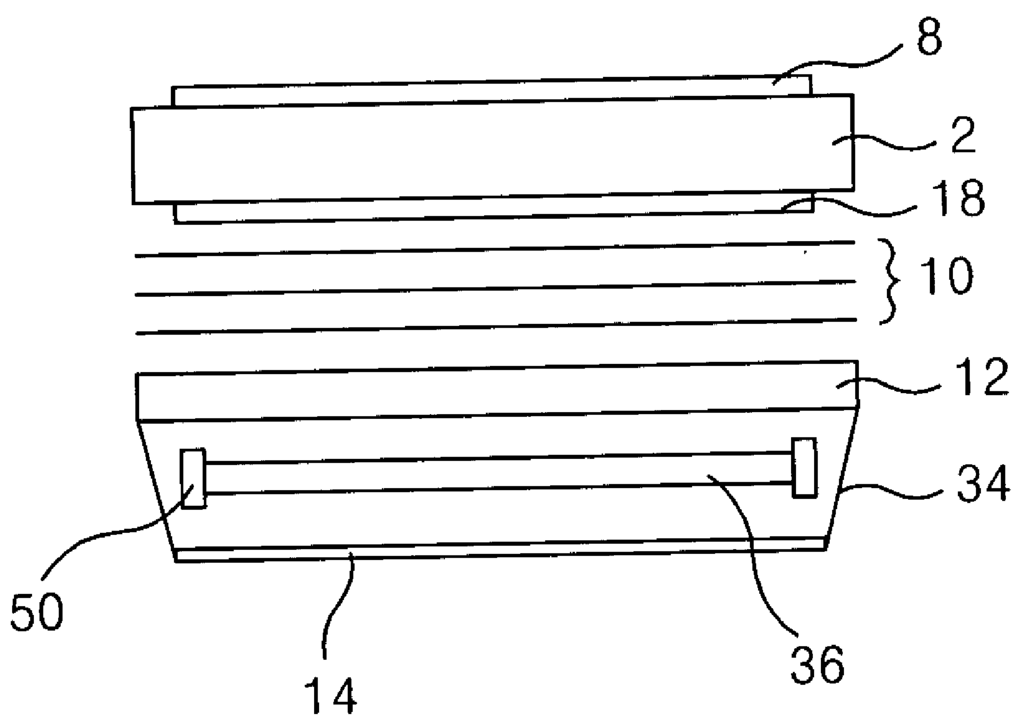


FIG.3

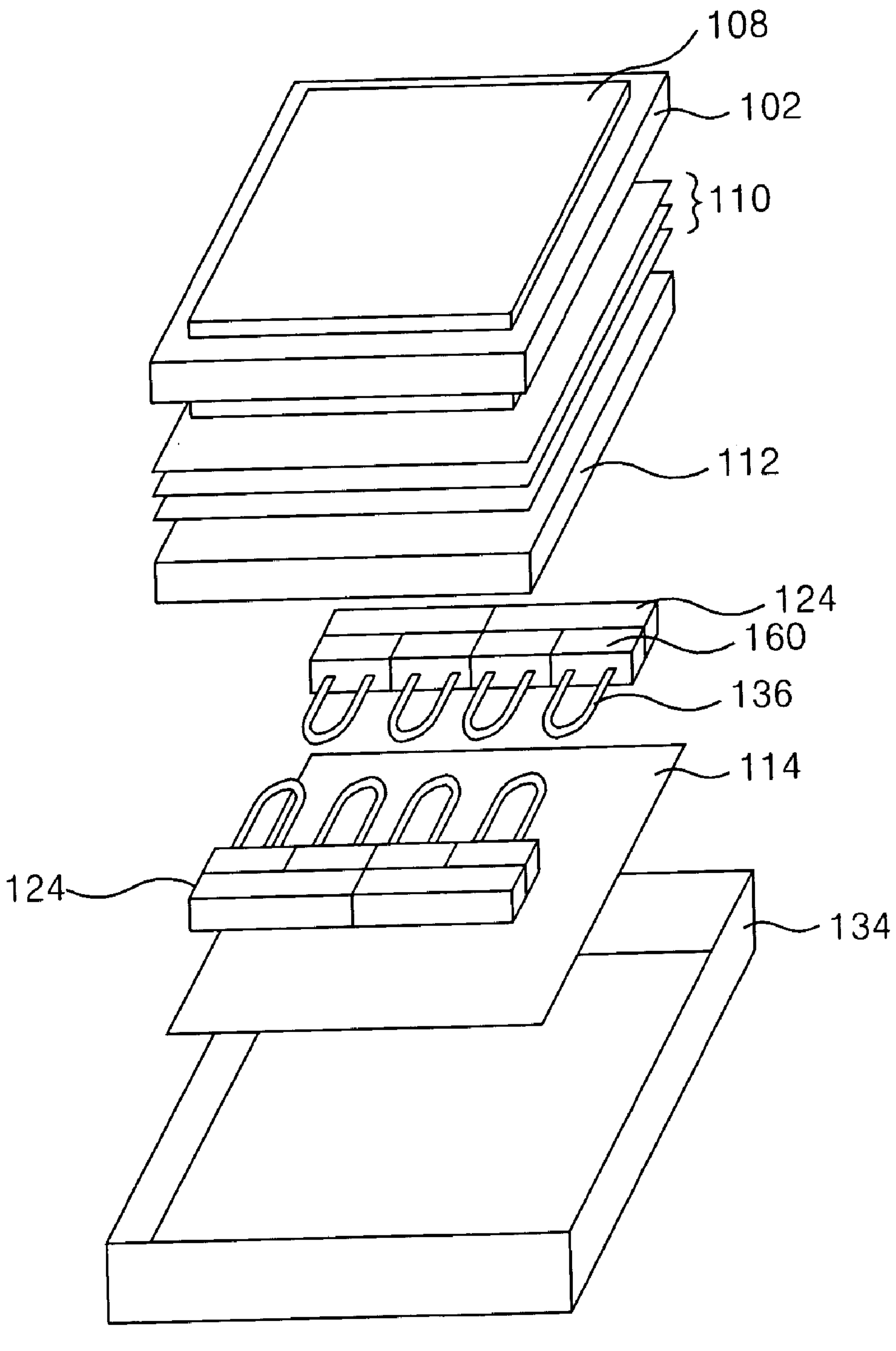


FIG.4

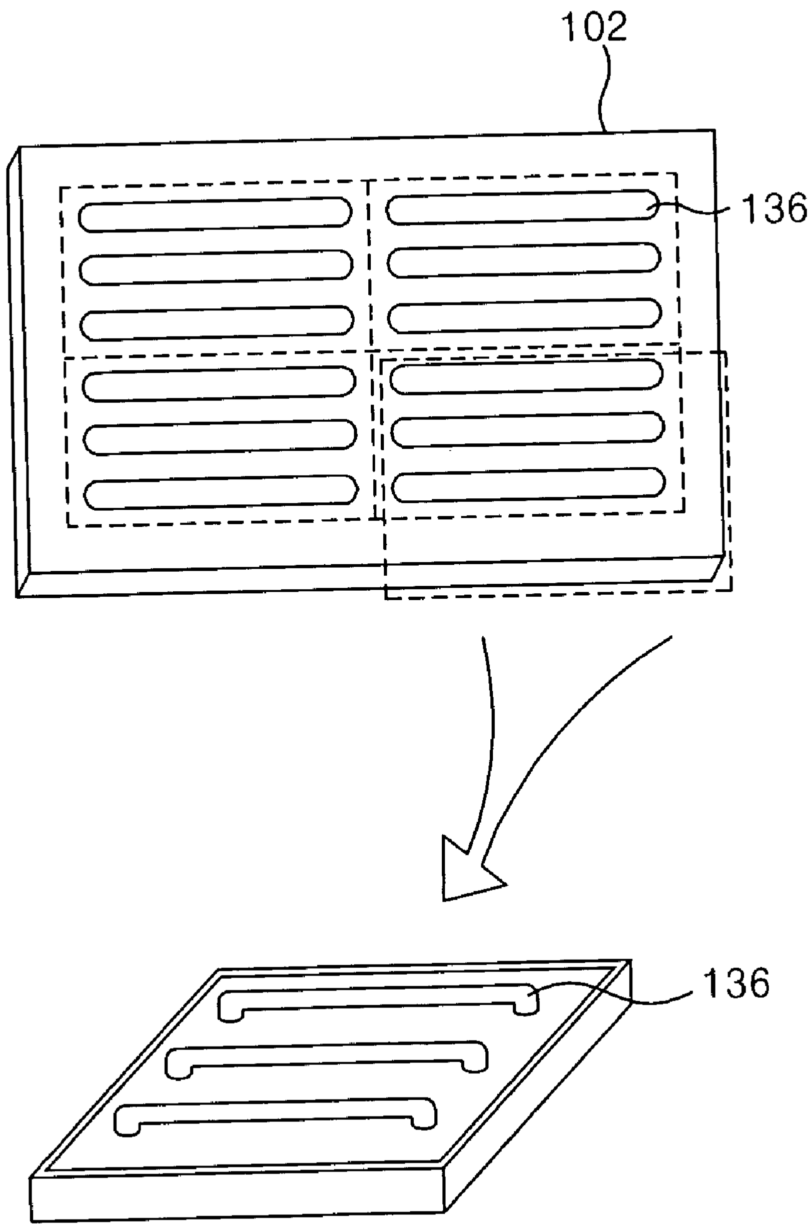


FIG.5

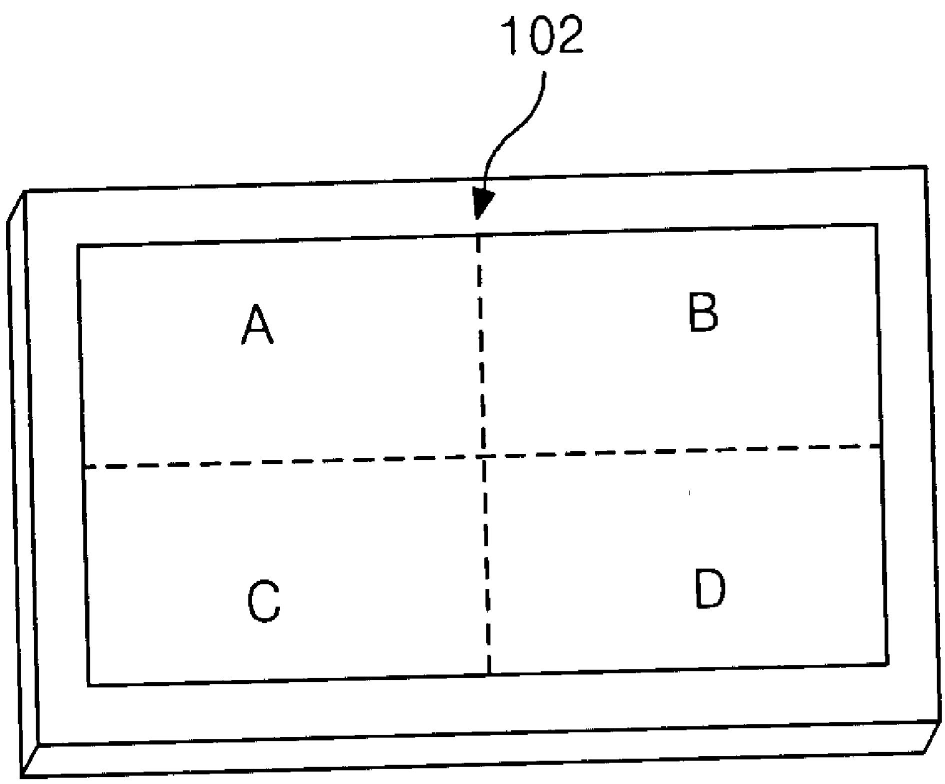


FIG.6

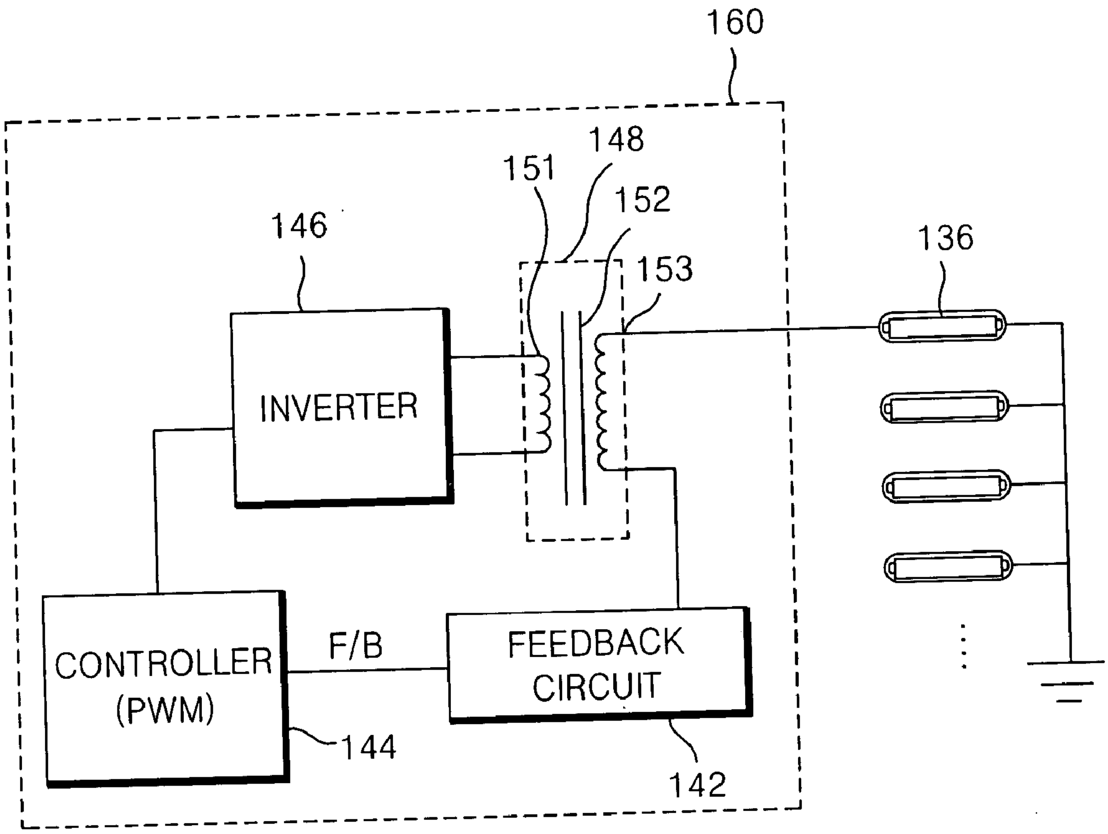

160
148
151
152
146
153
136
INVERTER
CONTROLLER
(PWM)
F/B
FEEDBACK
CIRCUIT
144
142

FIG. 7

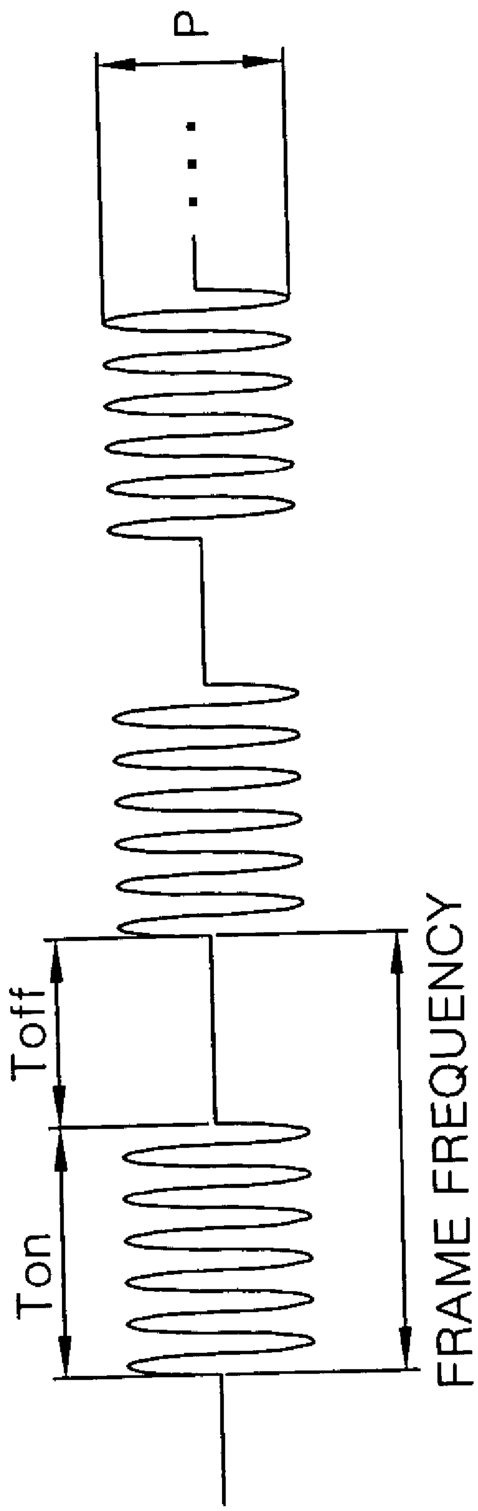


FIG.8

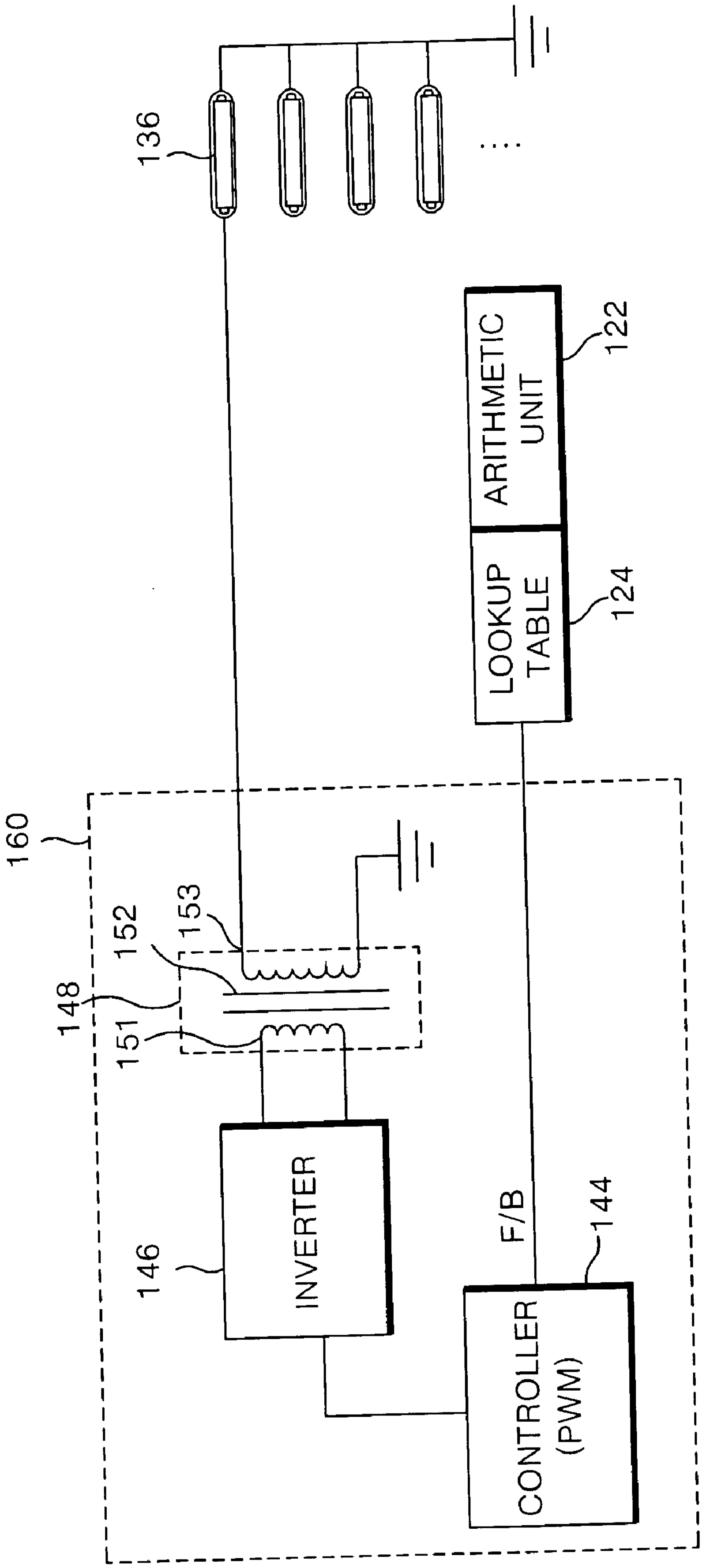

136
....
ARITHMETIC UNIT
122
LOOKUP TABLE
124
160
153
152
148
151
INVERTER
146
F/B
144
CONTROLLER (PWM)

FIG.9A

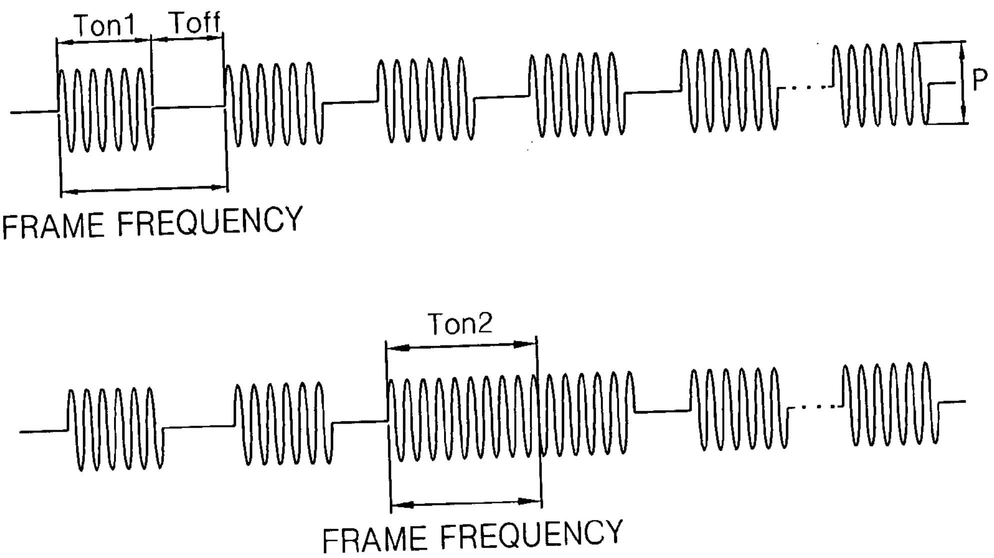


FIG.9B

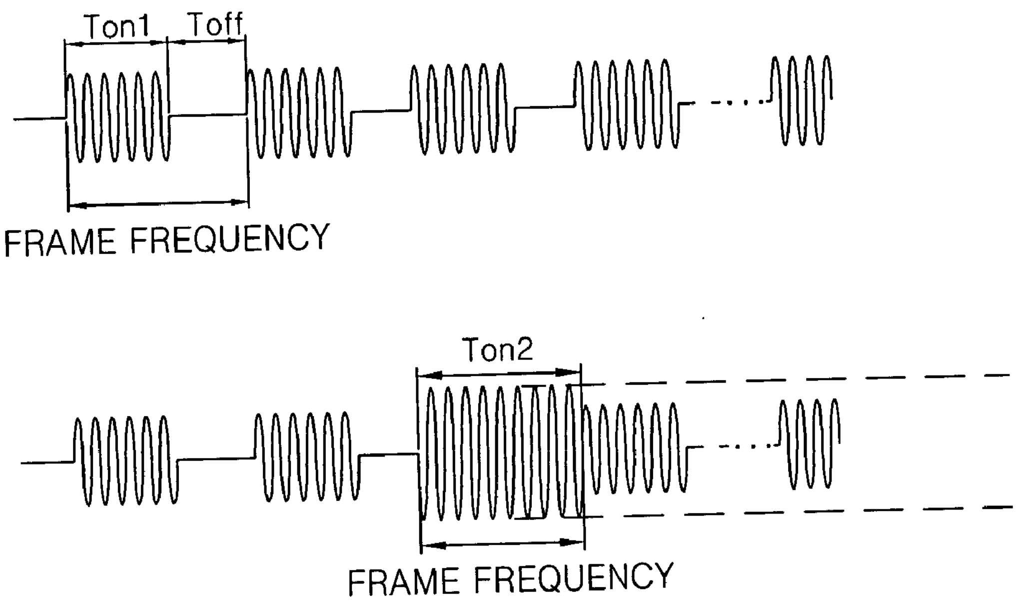


FIG.9C

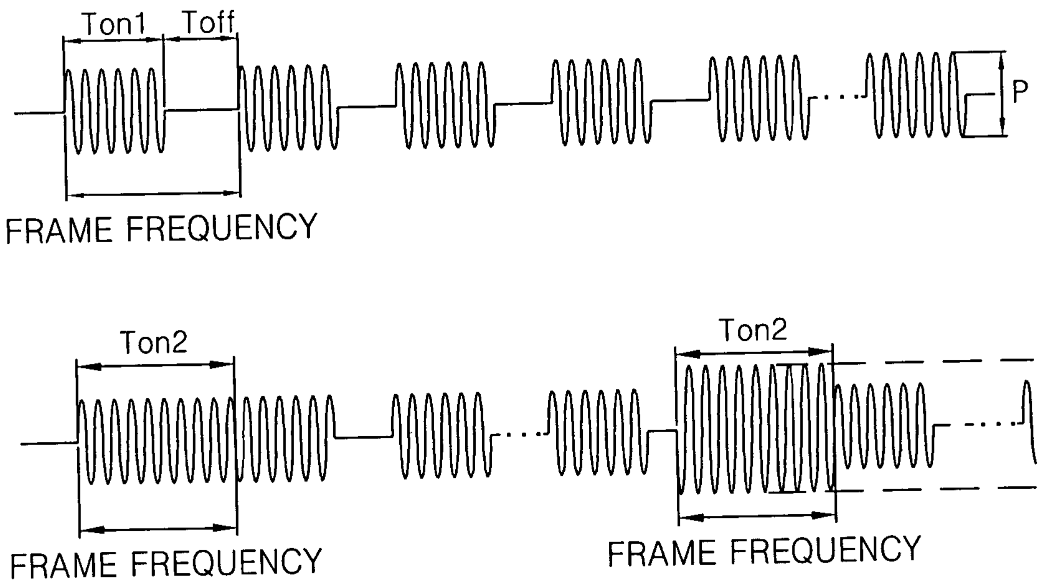
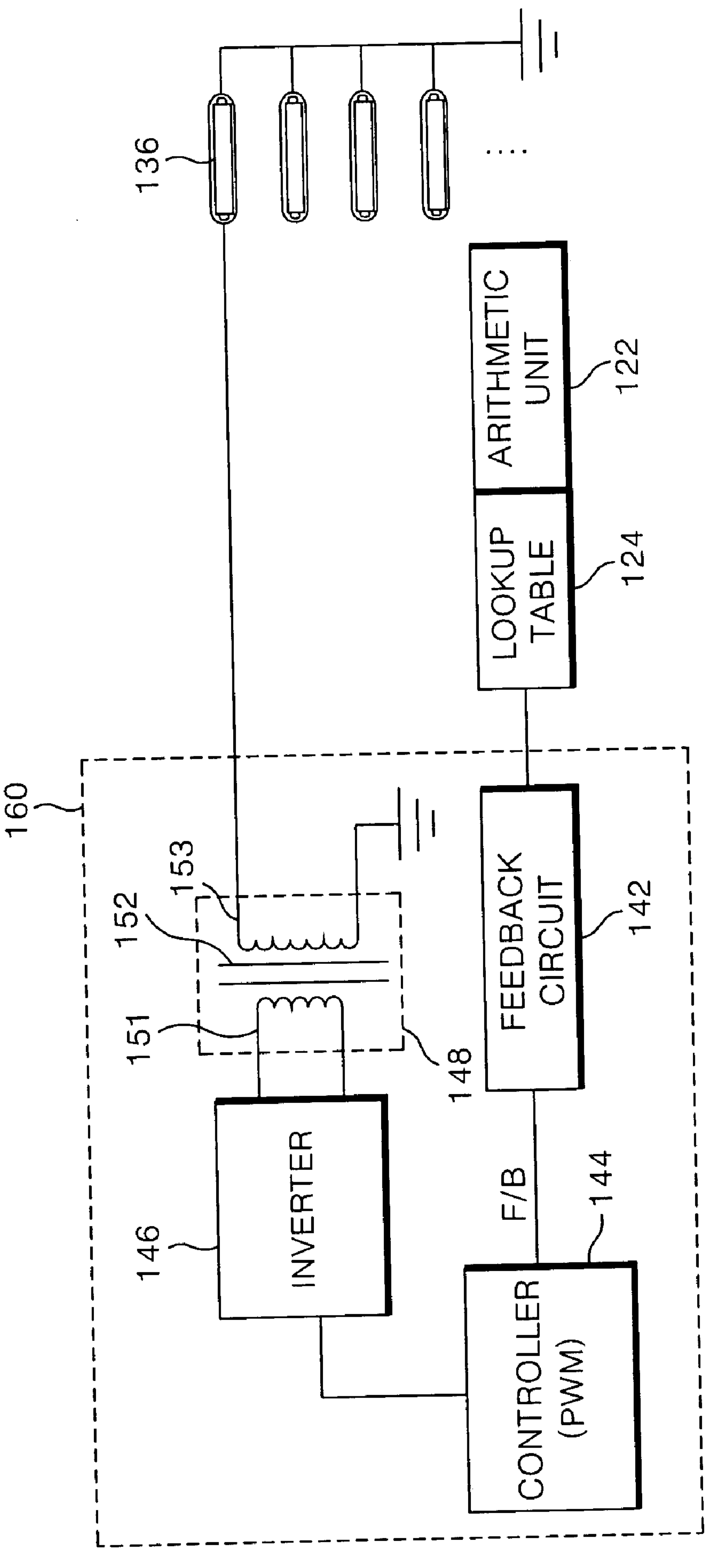

Ton1
Toff
P
FRAME FREQUENCY
Ton2
Ton2
FRAME FREQUENCY
FRAME FREQUENCY

FIG. 10


136
ARITHMETIC UNIT
122
LOOKUP TABLE
124
160
153
152
151
148
FEEDBACK CIRCUIT
142
INVERTER
146
F/B
144
CONTROLLER (PWM)

APPARATUS AND METHOD FOR LUMINANCE CONTROL OF LIQUID CRYSTAL DISPLAY DEVICE

[0001] This application claims the benefit of Korean Patent Application No. P2004-37769 filed in Korea on May 27, 2004, which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an apparatus and method for luminance control in a liquid crystal display device, and more particularly, to an apparatus and method for luminance control in a liquid crystal display device capable of reducing power consumption and improving picture quality by selectively driving a lamp.

[0004] 2. Description of the Related Art

[0005] The scope of application for liquid crystal displays (LCDs) continues to increase due to the advantages of LCDs, such as lightness, thinness, and low power consumption. Generally, LCDs are used in office automation devices, audio/video devices and the like. An LCD adjusts the transmittance of light beams in accordance with an image signal to display desired pictures on a screen.

[0006] Since the LCD is not a spontaneous light-emitting display device, the LCD device uses a back light unit as a light source. There are two types of back light units utilized in LCDs, a direct-below-type, and a light guide plate-type. In the direct-below-type, several lamps are arranged in the plane, and, a diffusion panel is installed between the lamp and the liquid crystal display panel to fix the distance between the liquid crystal display panel and the lamps. In the light guide plate-type, a lamp is installed in an outer part of the LCD device, and a transparent light guide plate provides/guides light such that it is incident to the whole surface of the liquid crystal display panel.

[0007] **FIGS. 1 and 2** illustrate a LCD with a direct-below-type backlight according to the related art. Referring to **FIG. 2**, the device includes a liquid crystal display panel **2** to display a picture, and a direct-below-type backlight unit to irradiate uniform light onto the liquid crystal display panel **2**.

[0008] In the liquid crystal display panel **2**, liquid crystal cells (not shown) are arranged between an upper substrate and a lower substrate. In an active matrix type display panel, a common electrode and pixel electrodes are provided. Generally, the pixel electrodes (not shown) are formed on the lower substrate, also referred to as a thin film transistor substrate, for each liquid crystal cell, and the common electrode (not shown) is integrated with the front surface of the upper substrate. Each of the pixel electrodes are connected to a thin film transistor that is used as a switching device. The pixel electrodes along with the common electrode drive the liquid crystal panel in accordance with a data signal supplied through the thin film transistor, thereby displaying pictures corresponding to a video signal.

[0009] The direct-below-type backlight unit includes a plurality of lamps **36** arranged parallel to each other; a lamp housing **34** located at the lower part of the lamps **36**, a diffusion plate **12** covering the lamp housing **34**, and optical sheets **10** located on the diffusion plate **12**.

[0010] Each of the lamps **36** includes a glass tube filled with an inert gas, and a cathode and an anode installed at opposite ends of the glass tube. The inside of the glass tube is charged with the inert gas, and the phosphorus is spread over the inner wall of the glass tube.

[0011] In each of the lamps **36**, if an alternating current AC waveform of high voltage is applied to a high voltage electrode and a low voltage electrode from an inverter (not shown), electrons are emitted from the low voltage electrode L to collide with the inert gas inside the glass tube, thus the amount of electrons are increased in geometrical progression. The increased electrons cause electric current to flow in the inside of the glass tube, so that the inert gas is excited by the electron to emit ultraviolet ray. The ultraviolet rays collide with luminous phosphorus spread over the inner wall of the glass tube emitting visible light rays. The high voltage AC waveform is continuously supplied to the lamps **36**, therefore the lamps are always turned-on.

[0012] The lamp housing **34** prevents leakage of the visible light rays emitted from each of the lamps **36** and reflects light rays, progressing to the side and the rear surfaces of the lamps **36**, to the front surface, i.e., toward the diffusion plate **12**, thereby improving the efficiency of the light generated at the lamps **36**.

[0013] The diffusion plate **12** directs the light emitted from the lamps **36** towards the liquid crystal display panel 2 and to be incident in an angle of a wide range. This is achieved, for example, by coating the diffusion plate **12** on both sides with a transparent resin.

[0014] The optical sheets **10** narrow the viewing angle of the light emitted from the diffusion plate **12**, to improve the front brightness and reduce power consumption in the liquid crystal display device.

[0015] A reflection sheet **14** is arranged between the lamps **36** and the lamp housing **34** to reflect the light generated from the lamps **36** so as to direct it towards the liquid crystal display panel **2**, thereby improving the efficiency of light.

[0016] The related art LCD generates a uniform light by use of the lamps **36** arranged in the lamp housing **34** to irradiate it to the liquid crystal display panel **2**, thereby displaying the desired picture. However, the lamps of the related art LCD are continuously turned-on, resulting in high power consumption and the inability to realize peak brightness, wherein peak brightness is that a designated part on the liquid crystal display panel **2** is instantly brightened in order to display a picture like an explosion or a flash on the liquid crystal display panel **2**.

SUMMARY OF THE INVENTION

[0017] Accordingly, the present invention is directed to an apparatus and method for luminance control in a liquid crystal display device that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

[0018] An advantage of the present invention is to provide an apparatus and method for luminance control of liquid crystal display device capable of reducing a power consumption and improving picture quality by selectively driving a lamp.

[0019] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims thereof as well as the appended drawings.

[0020] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described,

[0021] In another aspect of the present invention,

[0022] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

[0024] In the drawings:

[0025] **FIG. 1** is a perspective view illustrating a related art liquid crystal display device;

[0026] **FIG. 2** is a sectional view illustrating the liquid crystal display device taken along the line II-II' in **FIG. 1**;

[0027] **FIG. 3** is a perspective view illustrating a liquid crystal display device according to an embodiment of the present invention;

[0028] **FIG. 4** illustrates an another type lamp driven according to the embodiment of the present invention;

[0029] **FIG. 5** illustrates the division of a liquid crystal display panel into designated areas according to an embodiment of the present invention;

[0030] **FIG. 6** is an enlarged block diagram showing the lamp driving device according to an embodiment of the present invention;

[0031] **FIG. 7** illustrates a waveform generated from a pulse width modulation (PWM) controller according to an embodiment of the present invention;

[0032] **FIG. 8** is a block diagram showing a luminance control apparatus according to an embodiment of the present invention;

[0033] **FIGS. 9A** to **9C** illustrate other waveforms generated from the PWM controller according to an embodiment of the present invention; and

[0034] **FIG. 10** is a block diagram illustrating a luminance control apparatus according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0035] Reference will now be made in detail to embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0036] **FIG. 3** is a perspective view illustrating a liquid crystal display device according to an embodiment of the present invention. Referring to **FIG. 3**, the liquid crystal display device according to an embodiment of the present invention includes: a liquid crystal display panel **102**; and a backlight unit having a plurality of lamp units **136**, each lamp unit irradiating light to a designated area of the liquid crystal display panel **102**.

[0037] In the liquid crystal display panel **2**, liquid crystal cells (not shown) are arranged between an upper substrate and a lower substrate. In an active matrix type display panel, a common electrode and pixel electrodes are provided. Generally, the pixel electrodes (not shown) are formed on the lower substrate, also referred to as a thin film transistor substrate, for each liquid crystal cell, and the common electrode (not shown) is integrated with the front surface of the upper substrate. Each of the pixel electrodes are connected to a thin film transistor that is used as a switching device. The pixel electrodes along with the common electrode drive the liquid crystal panel in accordance with a data signal supplied through the thin film transistor, thereby displaying pictures corresponding to a video signal.

[0038] The backlight unit includes a plurality of lamp units **136**; a lamp housing **134** holding the lamp units **136**; a diffusion plate **112** that diffuses light generated from the lamp housing **134**; and optical sheets **110** that increase the efficiency of the light emitted from the diffusion plate **112**.

[0039] Each of the lamp units **136** includes a plurality of lamps; an arithmetic unit **122** to scan a pixel value of the designated area of the liquid crystal display panel **102**; a lookup table **124** that maps the resultant values calculated by the arithmetic unit **122** to a control signal; and a lamp driver **160** that drives the plurality of lamps in accordance with the control signal, as illustrated in **FIG. 10**.

[0040] Each lamp includes a glass tube filled with an inert gas, and a cathode and an anode installed at opposite ends of the glass tube. The inside of the glass tube is charged with the inert gas, and the phosphorus is spread over the inner wall of the glass tube. The lamps arranged parallel to each other in the lamp units **136**.

[0041] The lamp housing **134** prevents leakage of the visible light rays emitted from each of the lamps and reflects light rays, progressing to the side and the rear surfaces of the lamps, to the front surface, i.e., toward the diffusion plate **112**, thereby improving the efficiency of the light generated from the lamps.

[0042] The diffusion plate **112** directs the light emitted from the lamps towards the liquid crystal display panel **102** and to be incident in an angle of a wide range. This is achieved, for example, by coating the diffusion plate **112** on both sides with a transparent resin.

[0043] As illustrated in **FIGS. 3 and 4**, each of the lamps in the plurality of lamp units **136** is formed in a "U" shape, and arranged in the housing **134** such that the middle of the lamp is directed towards the surface of the diffusion plate **112**. However, the lamps may be formed in other shapes, for example, an "L" shape, a linear shape, a round shape, or the like. Accordingly, the liquid crystal display device according to the present invention is not limited by the shape of the lamps.

[0044] The optical sheets **110** narrow the viewing angle of the light emitted from the diffusion plate **112** to improve front brightness and reduce power consumption in the liquid crystal display device.

[0045] A reflection sheet **114** is arranged between the lamp units **136** and the lamp housing **134** to reflect the light generated from the lamps and direct it in the direction of the liquid crystal display panel **102**, thereby improving the light efficiency.

[0046] The arithmetic unit **122** scans each sub-pixel or cell (for example, red, green, and blue) in the liquid crystal display panel to determine a peak value for each pixel. Then an average peak value is calculate for each designated area, for example, areas A, B, C and D as illustrated in **FIG. 5**, of the liquid crystal display panel. The arithmetic unit **122** includes a scan part to detect the pixel value of each divided area, and a calculating part to extract the peak value of the sub-pixels among the pixels detected from the scan part and to calculate the average value of the extracted peak values.

[0047] Assuming the liquid crystal display panel is divided into four areas as illustrated in **FIG. 5**, and the RGB values of the pixels displayed "A" area are measured as in the following Table 1, then the average peak value for area A is calculated as discussed below.

TABLE 1

	Pixel 1	Pixel 2	Pixel 3	Pixel 4	...	Pixel End
R (red) sub-pixel	10	90	10	10	...	100
G (green) sub-pixel	30	30	50	200	...	20
B (blue) sub-pixel	60	10	60	60	...	60
Peak Value	60	90	60	200	...	100

[0048] First, the peak value among the sub-pixel values, i.e., the RGB values, for each of the pixels determined. For example, as shown in Table 1, the values for the red, green and blue sub-pixels of pixel 1 are 10, 30 and 60, respectively. Accordingly, the peak value for pixel 1 is 60, which corresponds to the blue sub-pixel. The values for the red, green and blue sub-pixels of pixel 2 are 90, 30, 10, respectively. Accordingly, the peak value for pixel 2 is 90, which corresponds to the red sub-pixel. In this way, the peak value among the RGB values of each pixel within area A is selected. The selected peak values are then added and divided by the number of the whole pixels within the designated area to determine the average value of each pixel displayed in area "A". Therefore, assuming the total number of pixels in area "A" is 10, and the sum of the peak values is 1000, then the average peak value for area "A" is 100.

[0049] The lookup table **124** maps the average peak value for an area to a control signal in order to control the lamp driver **160**. The lookup table **124** may be included in the arithmetic unit **122** or be separate from the arithmetic unit. In addition, the values stored in the lookup table **124** may be changed in accordance with the requirement of a user or the needed image display.

[0050] The lamp driver **160**, as illustrated in **FIG. 6**, includes an inverter **146**; a transformer **148** arranged between the inverter **146** and one end of the lamps **136**; a feedback circuit **142** arranged between the transformer **148** and one end of the lamp; and a pulse width modulation ("PWM") controller **144** arranged between the inverter **146** and the feedback circuit **142**.

[0051] The inverter **146** converts the voltage supplied from the voltage source into the AC waveform using a switch device that is switched by the pulse generated from the PWM controller **144**. The AC voltage waveform is then transmitted to the transformer **148**. The transformer **148** boosts the AC waveform supplied from the inverter **146** to a high voltage AC waveform in order to drive the lamps **136**. For this, a primary winding **151** of the transformer **148** is connected to the inverter **146**, a secondary winding **153** is connected to the feedback circuit **142**, and an auxiliary winding **152** is arranged there between, wherein the auxiliary winding induces the voltage of the primary winding **151** to the secondary winding **153**. As a result, the AC waveform supplied from the inverter **146** is boosted to the AC waveform of high voltage based on the winding ratio between the primary winding **151** and the secondary winding **153**. The high voltage waveform is then supplied to the lamps.

[0052] The feedback circuit **142** detects the current transmitted to the lamps and generates a feedback voltage. The feedback circuit **142** may be located at the output terminal of the lamps to detect the output value outputted from the lamps. The PWM controller **144** controls the switching of the switch device based on the received feedback.

[0053] Each of the PWM controllers **144** controls the switching of the switch device of the inverter **146** to change the AC waveform for each of the designated areas. The AC waveform generated from the PWM controller **144** and transmitted to the inverter **146**, as shown in **FIG. 7**, is divided into an on-time when a pulse is formed and an off-time when the pulse is not supplied.

[0054] A method of controlling luminance in a liquid crystal display device according the present invention will be described with respect to FIGS. **8** to **9**C. Referring to **FIG. 8**, first, the average peak value for the pixels in a designated area A, B, C, D of the liquid crystal display panel **102** is calculated by the arithmetic unit **122**. The average peak value is then mapped using the lookup table **124** to a control signal. Then the control signal is transmitted to the PWM controller **144**. The control signal may change the duty ratio of the pulse generated from the PWM controller **144**, as illustrated in **FIG. 9A**, the amplitude of the pulse generated from the PWM controller **144**, as illustrated in **FIG. 9B**, or both the duty ratio of the pulse and the amplitude of the pulse generated from the PWM controller **144**, as illustrated in **FIG. 9C**.

[0055] The feedback circuit **142** may be eliminated in order to minimize the lamp driver **160**. Accordingly, the pulse signal of the PWM controller **144** included in the lamp driver **160** might be change by the arithmetic unit **122** and the lookup table **124**. That is, the feedback circuit **142** might be eliminated in the liquid crystal display device according to the present invention. Accordingly, in the diagram shown in **FIG. 8**, the feedback circuit is eliminated.

[0056] Further, as illustrated in **FIG. 10**, when the control signal is transmitted to the feedback circuit **142**, the control signal converts the feedback voltage generated from the feedback circuit **142**, thereby indirectly converting the pulse generated from the PWM controller **144**. The pulse generated from the PWM controller **144** that is changed in accordance with the feedback voltage is as shown in **FIGS. 9A** to 9C.

[0057] Next, the pulse generated in accordance with the pulse width and/or duty ratio converted from the PWM controller **144** controls the switch device of the inverter **146** to change the tube current generated from the transformer **148** corresponding thereto and supplied to the lamps.

[0058] According to this method, assuming that in the average value of each area of **FIG. 5**, the peak average value of "A" area is 100, the peak average value of "B" area is 300, the peak average value of "C" area is 100, the peak average value of "D" area is 500 and the minimum and maximum range of the average value between areas is 0 to 1000, the duty ratio of the pulse generated from the PWM controller **144** has the lamp duty ratio of "A" area 10%, the lamp duty ratio of "B" area 30%, the lamp duty ratio of "C" area 10% and the lamp duty ratio of "D" area 50%. The change of the duty ratio changes the tube current flowing in each of the lamps **136**, thereby controlling the brightness. Herein, the same effect might be obtained by use of the change of the amplitude of the pulse as well as the duty ratio of the pulse. Further, the arithmetic unit **122** and the lookup table **124** might be manufacture inside the lamp driver **160** as the user requires.

[0059] As described above, in the luminance control apparatus and method of the liquid crystal display device according to the embodiment of the present invention, the tube current flowing in the lamp that irradiates light to each division area of the liquid crystal display panel is changed. Accordingly, it is more suitable to express a motion picture and an image with high brightness difference than the method of driving the lamp of the whole screen of the related art. In other words, the lamp current value of the division area is determined by the average value of the peak value of the image pixels to increase the brightness of the lamp in the area where there are more bright images and to decrease the brightness in the area where there are more dark images, thereby realizing the vivid screen. Further, in the luminance control apparatus and method of the liquid crystal display device according to the embodiment of the present invention, it is possible to reduce a power consumption by dividedly driving each lamp.

[0060] Although the present invention has been explained by the embodiments shown in the drawings described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the embodiments, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents.

1. A luminance control apparatus of a liquid crystal display device comprising:

a liquid crystal display panel;

plurality of lamp units, each lamp unit providing light to a designated area of the liquid crystal display panel;

an arithmetic unit configured to calculate an average peak value of the pixels within each designated area; and

a lamp driver for each of the plurality of lamp units, each lamp driver configured to control the lamp unit providing light to a designated area based on the calculated average peak value for the designated area.

2. The luminance control apparatus according to claim 1, wherein the arithmetic unit is further configured to extract a peak value of a sub-pixel having a maximum gray level among a red sub-pixel, a green sub-pixel and a blue sub-pixel for each of the pixels included in the designated area.

3. The luminance control apparatus according to claim 2, wherein the arithmetic unit comprises:

a scan part configured to detect values of sub-pixels for each image pixel in the designated area of the liquid crystal display panel; and

a calculating part configured to calculate the average peak value.

4. The luminance control apparatus according to claim 1, further comprising:

a lookup table arranged between the arithmetic unit and the lamp driver, the lookup table configured map the average peak value calculated by the arithmetic unit to a control signal.

5. The luminance control apparatus according to claim 1, wherein the lamp driver includes:

an inverter circuit that boosts a voltage supplied from a power source, to generate a boosted alternating current signal, and supplies it to the lamp units; and

a pulse width modulator arranged between the inverter circuit and the lamp unit to control the signal generated from the inverter circuit in accordance with the average peak value calculated by the arithmetic unit.

6. The luminance control apparatus according to claim 1, wherein the arithmetic unit is integrated within the lamp driver.

7. A method for controlling luminance in a liquid crystal display device, the liquid crystal display device comprising a plurality of lamp units each, each lamp unit providing light to a designated area of the liquid crystal display panel, the method comprising:

calculating an average peak value for pixels within the designated areas of the liquid crystal display panel; and

controlling the luminance of the plurality of lamp units based on the calculated average peak value for a designated area.

8. The luminance control method according to claim 7, wherein the calculating the average peak value for each designated area of the liquid crystal display panel comprises:

scanning each pixel within each designated area of the liquid crystal display panel;

determining a peak value for each pixel within a designated area; and

calculating an average value of the peak values for the pixels within each designated area.

9. The luminance control method according to claim 7, wherein controlling the luminance of the plurality of lamp units based on the calculated average peak value for a designated area comprises:

converting at least one of a pulse duty ratio and a pulse amplitude of a pulse driving the lamp units based on the average peak value; and

converting a tube current to be supplied the lamp unit in accordance with at least one of the converted pulse duty ratio and pulse amplitude.

* * * * *

专利名称(译)	用于液晶显示装置的亮度控制的装置和方法		
公开(公告)号	US20060007100A1	公开(公告)日	2006-01-12
申请号	US11/136666	申请日	2005-05-25
[标]申请(专利权)人(译)	HONG HEEĴ KWON KYUNGĴ		
申请(专利权)人(译)	HONG HEEĴ KWON KYUNGĴ		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	HONG HEE JUNG KWON KYUNG JOON		
发明人	HONG, HEE JUNG KWON, KYUNG JOON		
IPC分类号	G09G3/36 G02F1/133 F21S2/00 G02F1/13357 G09G3/20 G09G3/34 H05B41/392		
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外部链接	Espacenet USPTO		

摘要(译)

一种用于控制液晶显示装置中的亮度的装置和方法，包括：具有至少两个指定区域的液晶显示板;至少两个灯单元照射液晶显示板的指定区域;运算单元，用于扫描液晶显示面板的每个指定区域内的图像像素，提取像素灰度级的峰值，并计算每个指定区域的平均峰值;灯驱动器，被配置为控制灯单元，基于平均峰值将光照射到每个指定区域。