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(54) Liquid crystal display

(57) An LCD display device such as a television or computer monitor comprises an LCD display 10, and a photo sensor 15 for sensing the ambient lighting level within a room in which the display 10 is situated. The device further comprises an electronic circuit for analysing the video content of a picture being displayed on the display 10, and a control circuit connected to both the output of the photo sensor 15 and video analysing circuit 13. The control circuit determines the brightness of a back light 11 which illuminates the LCD display 10. The brightness of the back light is dependent on the ambient lighting levels and the video content of the picture and is varied accordingly so as to optimise the contrast of the displayed picture.

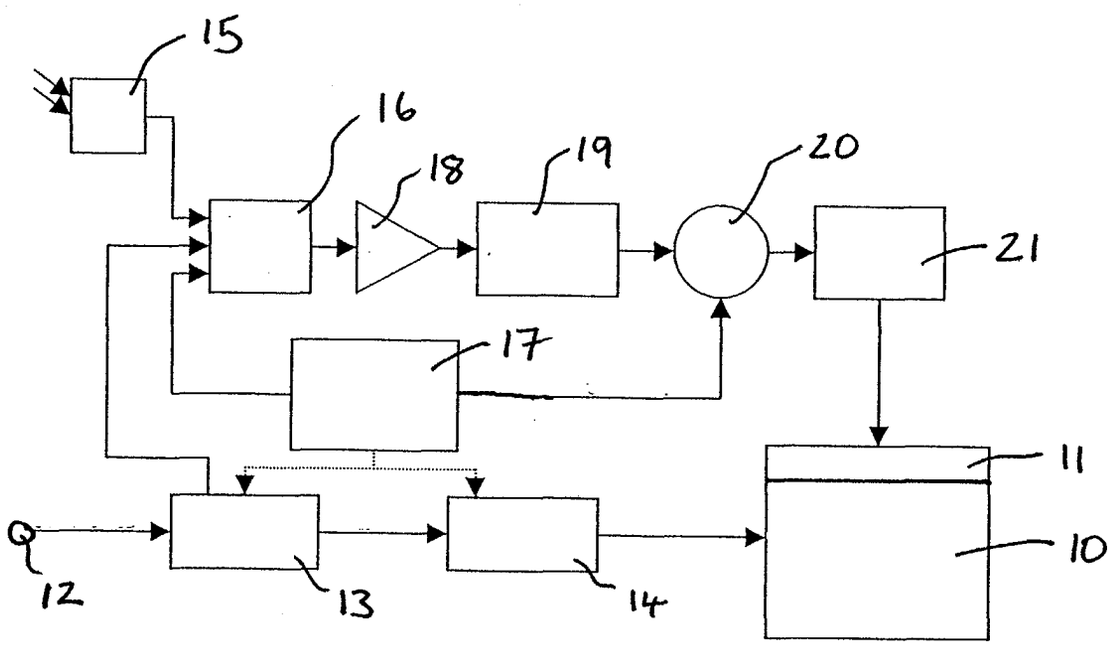

FIGURE 1

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Description

[0001] This invention relates to a liquid crystal or so-called LCD display and more particularly to the control of backlighting in an LCD display.

[0002] Historically, cathode ray tubes have widely been used to display video images in television receivers, computer monitors and the like. Cathode ray tubes are relatively heavy and bulky items and, with the improvement in manufacturing techniques of large colour LCD displays, it has become popular to use such displays in television receivers, computer monitors and the like.

[0003] An LCD display for a television receiver, computer monitor or the like comprises a transparent glass panel having an array of pixels. Each pixel comprises juxtaposed red, green and blue filters overlying respective opaque liquid crystal segments. In use, the panel is backlit with diffuse white light and the liquid crystal segments of each pixel are appropriately controlled to allow the white light to pass through selected filters according to the desired colour of the pixel.

[0004] In order to display a black area, the opaque LCD segments in that area are de-energised to prevent the white light from passing through the pixels. However, a disadvantage of this is that the LCD material is not truly opaque and as a result some of the light passes through the LCD material making the area of the picture appear grey rather than black.

[0005] We have now devised an LCD display which alleviates the above-mentioned problems.

[0006] In accordance with this invention, there is provided an LCD display device comprising an LCD display, a photo sensor for sensing the ambient lighting level in the vicinity of the display, means for analysing the video content of the picture being displayed on the display and control means connected to outputs of the sensor and video analysing means for varying the brightness of a back light of the display in accordance with signals output from the sensor and video analysing means.

[0007] We have realised that the severity of the above-mentioned problem depends upon two factors, firstly, the ambient lighting within the room where the display is situated and, secondly, the video content of the displayed picture.

[0008] In situations where the LCD display is situated in a brightly lit room, the viewer's perception of black is not as great as it would be in a dark room.

[0009] Also, in situations where the LCD display device is displaying bright pictures having a high video content or significant areas of a high content, the viewer's perception of black is not as great as it would be for dark pictures with a low video content (or significant areas of a low content).

[0010] The present invention thus varies the brightness of the back light in accordance with the outputs of both a photo sensor which senses the ambient lighting and means which analyses the video content of the displayed picture.

[0011] Preferably, the brightness of the back light is reduced when the sensor senses that the ambient lighting level has reduced and vice-versa.

[0012] Preferably, the brightness of the back light is reduced when the analysing means detects a video picture signal having a low video content (or significant areas of a low content) and vice-versa.

[0013] In order to prevent undue variations in the brightness of the displayed picture, under conditions where the analysing means detects a video picture signal having a high video content (or significant areas of a high content), the brightness of the back light is preferably maintained at a predetermined level regardless of the output of the sensor. The reason for this is that a viewer's perception of the black content within a bright picture will be substantially the same under both bright and dark ambient lighting conditions.

[0014] Also, in order to prevent undue variations in the brightness of the displayed picture, under conditions where the analysing means detects bright ambient lighting conditions, the brightness of the back light is preferably maintained at a predetermined level regardless of the output of the video analysing means. The reason for this is that a viewer's perception of the black content of a picture signal under bright ambient lighting conditions will be substantially the same whether the video picture signal has a high or low video content (or significant areas of high or low content).

[0015] Thus, taking into account both of the above-mentioned factors, the back light brightness is preferably only reduced for pictures with a low video content viewed in conditions of low ambient lighting.

[0016] Preferably means are provided on the display to enable the viewer to adjust said predetermined brightness level of the back light.

[0017] Preferably, said predetermined brightness level is a maximum level, the brightness being reduced below said level in accordance with the signals output from the sensor and video analysing means.

[0018] Preferably the brightness level of the back light is varied in a framewise manner in accordance with the signals output from the sensor and video analysing means.

[0019] Preferably the sensor is directed away from the display or otherwise shielded to prevent light incident from the display affecting the brightness of the back light.

[0020] Preferably the means for analysing the video content of the picture being displayed analyses the average video content over a plurality of frames (eg 10), in order to avoid sudden changes in backlighting conditions.

[0021] An embodiment of this invention will now be described by way of an example only and with reference to the accompanying drawings, in which:

Figure 1 is a schematic circuit diagram of a portion

of an LCD display device in accordance with this invention; and

Figure 2 is a graph explaining the operation of the circuit of the display device of Figure 1.

[0022] Referring to Figure 1 of the drawings, an LCD display device such as a television receiver or computer monitor comprises a conventional colour LCD display panel 10 which is backlit by a back light 11, which emits substantially white light. The display panel 10 is arranged to display coloured pictures in accordance with signals applied to an input 12 of the circuit and fed to the panel 10 via a video processor 13 and scaling circuit 14.

[0023] A photo sensor 15 is mounted to the front of the LCD display device and is arranged to sense the ambient lighting conditions within the room in which the LCD display device is situated. The output of the sensor 15 is connected to an input of a summation circuit 16 having other inputs respectively connected to a microprocessor 17 and a luminance/chrominance output from the video processor 13.

[0024] The output of the summation circuit 16 is connected via an amplifier 18 to a signal processing circuit 19. The output of the signal processing circuit 19 is connected to the back light 11 via a modulator 20 and a low pass filter 21.

[0025] The microprocessor 17 controls many aspects of the operation of the display devices and has inputs connected to actuators and the output of an infra-red receiver, which allow the user to adjust various settings of the device. An output of the microprocessor 17 is connected to the modulator 20.

[0026] In use, the summation circuit 16 adds the output of the photo sensor 15 to the luminance/chrominance output from the video processor 13 and to a control output from the microprocessor 17. The control output from the microprocessor 17 carries a signal dependant on whether the user has selected or deselected adaptive brightness control of the back light.

[0027] The output signal from the summation circuit 16 is amplified by the amplifier 18 and then passed through the signal processing circuit 19 which applies a non-linear transfer function to the signal, so that the output of the circuit 19 only varies when the average video content is low and the ambient lighting is low.

[0028] The normal brightness of the back light 11 is selected by the user and the microprocessor 17 applies an appropriate pulse-width modulated brightness control signal to the back light 11 via the modulator 20 and low pass filter 21. The modulator 20 has the effect of modulating the output of the signal processing circuit 19 onto the brightness control signal, such that the brightness of the back light 11 is only reduced from the user selected level when the average video content is low and the ambient lighting is low. The low-pass filter 21 acts to remove any high frequency signals which could cause unwanted sudden variations in the back light brightness.

[0029] Referring to Figure 2 of the drawings, the intensity level of the back light 11 is normally maintained at 100% of that selected by the user until both the level of the average video content and the ambient lighting fall below predetermined levels, whereupon the intensity level of the back light 11 is reduced. The predetermined levels at which the brightness is varied are preprogrammed into the signal processing circuit 19. Likewise, the rate of reduction of the intensity level of the back light 11 in accordance with both the level of the average video content and the ambient lighting is preprogrammed into the signal processing circuit 19.

[0030] An LCD display device such as a television receiver or computer monitor in accordance with this invention thus has a substantially improved picture impression compared with conventional devices.

Claims

1. An LCD display device comprising an LCD display, a photo sensor for sensing the ambient lighting level in the vicinity of said display, means for analysing the video content of the picture being displayed on said display and control means connected to outputs of said sensor and video analysing means for varying the brightness of a back light of said display in accordance with signals output from said sensor and video analysing means.

2. An LCD display device as claimed in claim 1, in which the brightness of said back light is reduced when said sensor senses that the ambient lighting level has reduced and vice-versa.

3. An LCD display device as claimed in claims 1 or 2, in which the brightness of said back light is reduced when said analysing means detects a video picture signal having a low video content (or significant areas of a low content) and vice-versa.

4. An LCD display device as claimed in any preceding claim, in which means are provided on said display to enable the viewer to adjust a predetermined brightness level of said back light.

5. An LCD display device as claimed in claim 4, in which said predetermined brightness level is a maximum level, the brightness being reduced below said level in accordance with the signals output from said sensor and video analysing means.

6. An LCD display device as claimed in any preceding claim, in which the brightness level of said back light is varied in a framewise manner in accordance with the signals output from said sensor and video analysing means.

7. An LCD display device as claimed in any preceding claim, in which said sensor is directed away from the display or otherwise shielded to prevent light incident from the display affecting the brightness of said back light.

8. An LCD display device as claimed in any preceding claim, in which said means for analysing the video content of the picture being displayed analyses the average video content over a plurality of frames, in order to avoid sudden changes in backlighting conditions.

9. An LCD display device substantially as herein described with reference to the accompanying drawings.

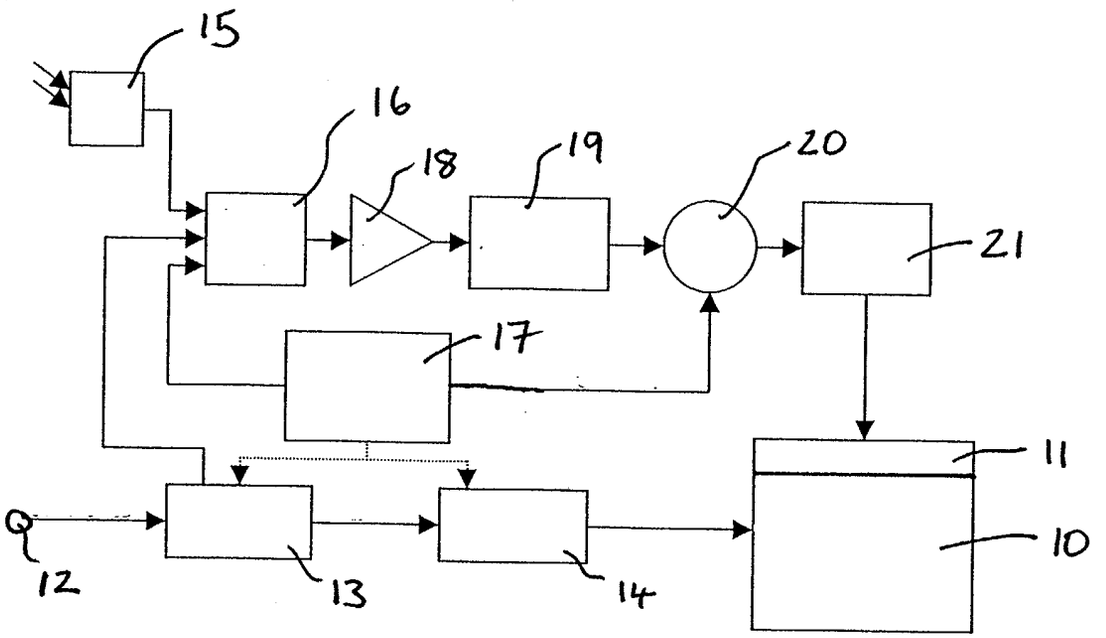

FIGURE 1

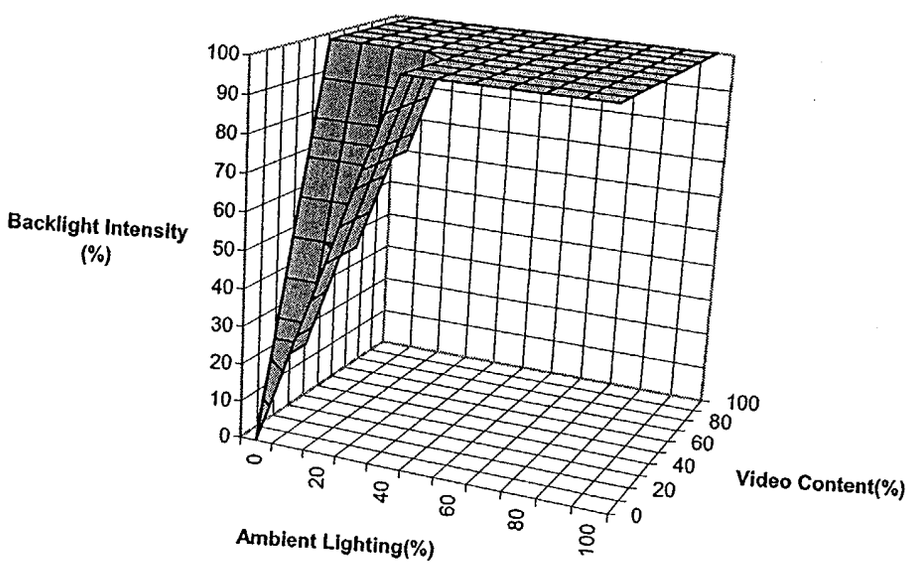

FIGURE 2