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10 The invention relates to a method and a device for optimizing the contrast and the angle of view of a liquid crystal display.

15 It applies more particularly, but not exclusively, to transmissive type liquid crystal displays intended to be observed along a given axis of vision. Such is the case in particular in the instrument panels of vehicles, and in particular of aircraft.

At the present time, numerous displays of this kind are equipped with means for adjusting the contrast, such adjustment being made at the beginning of a phase of use of the display and not being modified during this phase.

20 Now it proves that for multiple reasons this method of adjustment does not allow optimum contrast to be obtained durably for the desired angle of vision.

25 First of all, it has been observed that, when he makes the adjustment, the operator is rarely in the position of use, so that the adjustment made is not optimum.

30 Furthermore, once the adjustment has been made, the contrast frequently varies for multiple reasons such for example as a variation of the temperature of the liquid crystal which is difficult to compensate for by temperature controlling the control voltage of the LCD. Moreover, variations of the threshold voltage of crystals from different suppliers make this type of adjustment necessary.

35 It has also been proposed to adjust the liquid crystal cell so as to maintain the luminance of the light signals transmitted in a test zone substantially constant. However, such adjustment which is described in the "Patent Abstracts of Japan", vol. 9, no. 62 (page 342)

(1785) 19th May, 1985, does not provide a contrast control.

The purpose of the invention is then particularly to overcome these drawbacks.

5 For this, it provides a method according to the preamble of claim 1 for optimizing the contrast according to an angle of preferential view of a liquid crystal display.

10 According to the invention, this method is characterized by the features of the characterizing part of claim 1.

Of course, determination of the control voltage as a function of the determined contrast may be carried out in multiple ways.

15 Thus, for example, the contrast value determined at a time t may be subtracted from the contrast value determined at the preceding time $t-1$ and the value of the control voltage may be increased or possibly decreased as a function of the sign of this subtraction.

20 Of course, the invention relates also to a device for implementing the above defined method, one embodiment of which will be described hereafter by way of non limitative example, with reference to the accompanying drawings in which :

25 Figure 1 is a block diagram of a display equipped with this device ;

Figure 2 is a front view of a display panel usable in the device shown in figure 1 ; and

30 figures 3 and 4 are schematic sections respectively through A-A (figure 3) and B-B (figure 4) of the display panel shown in figure 2.

35 As mentioned above, the display according to the invention operates in transmissive mode and comprises, as shown in figure 1, a liquid crystal cell 1 illuminated on one side by a light device 2 and which is intended to be

observed on the other side along a preferential axis of vision D forming angles θ_1 and ϕ_1 with the normal to the plane of the cell.

This liquid crystal cell is controlled by a driver circuit of conventional type 4 adapted to apply a given control voltage V_{LCD} to selected electrodes of cell 1, selection of the electrodes, and consequently of the pixels of the image to be formed, being made by a computer (connection 6). In this example, the control circuit 4 comprises means for adjusting the control voltage which it delivers. However, contrary to existing circuits, these adjustment means do not comprise a potentiometer which can be operated by the user but are controlled by computer 5 (connection 7).

In accordance with the invention, computer 5 is adapted so as to apply a voltage to the electrodes of cell 1 included in a given test zone Z, which causes periodic energization of the pixels included in this zone, which then pass successively from the energized "ON" state to the de-energized "OFF" state, then again to the "ON" state and so on.

The light transmitted in this zone Z of the display is detected by a collimated photoelectric cell 8 (lens 9) oriented so as to be able to "observe" this zone along a given axis T parallel to the preferential axis of vision D.

This cell, as well as the zone of the display are protected from ambient light by an optical mask which, in the example shown in figures 2 to 4, consists in the cross piece 10 of a grid 11 applied against the front face of the liquid crystal cell 1 and which divides the latter into two display areas 12, 12'. Cell 8 is here disposed at the bottom of a well 13 formed in cross piece 10 coaxially to axis T. Its opening, which is applied against the cell, defines the test zone Z.

Of course, the invention is not limited to such an

arrangement. Thus, the photoelectric cell 8 and the optical system 9 which is associated therewith could be mounted in a device with variable orientation (for example by means of a ball joint) so that the user may adjust its orientation at his convenience.

The signal generated by cell 8, which consists of an alternating succession of values representative of the luminances of cell 1 in the energized state (i.e. L ON) and in the de-energized state (i.e. L OFF), is transmitted to computer 5, after shaping in an adapter 14.

This computer 5 is adapted so as to work out the quotient of the consecutive values L ON, L OFF of each pair, so as to be able to obtain at all times a value C representative of the contrast
$$C = \frac{L \text{ ON}}{L \text{ OFF}}$$

These contrast values are analyzed by computer 5 which causes the adjustment of the liquid crystal cell 1 to evolve so as to obtain maximum contrast in the preferential direction D. Similarly, grey levels may be taken into account and controlled simply.

Such as described, this device has the advantage of being independent :

- of threshold voltage variations of the crystal,
- of the ambient temperature, and
- of the usual adjustments on this type of display.

It further makes possible permanent self-testing of the display + lighting module assembly. In this case, it may possibly comprise means for generating an alarm signal when the value representative of the contrast is substantially equal to 1 or indeterminate after exploration of the whole possible control voltage range of the LCD.

Furthermore, computer 5 provides power control (via connection 15) of the lighting module 2 as a function of external reference information (coming for example from a control button 16), consequently the luminosity

measurement made by cell 8 makes it possible to check the correlation between the light power controlled by computer 5 and the luminance effectively measured by the cell through the display.

Of course, the invention is not limited to the above described embodiment. Thus, the liquid crystal cell could be of the reflective or translective type. In this case, the optoelectronic detection assembly will be disposed in a position removed from the display.



Claims

5 1. A method of optimizing the contrast according to a preferential axis of vision of a liquid crystal display, this method comprising the following phases :

- periodic excitation of a given zone (Z) of the display (1) ;

10 - permanent measurement of the luminance of said zone (Z) ; and

- adjustment of the control voltage of the liquid crystal cell (1) of the display as a function of the detected luminance, characterized in that :

15 - the periodic excitation of said zone is effected so as to cause it to pass successively from the energized "ON" state to the de-energized or "OFF" state, then again to the energized "ON" state and so on and to be able to discern the luminances of each successive energized state, de-energized state pair ;

20 - the measurement phase is carried out by means of a photoelectric cell(8) oriented for observing the said zone according to an axis parallel to said axis of vision, said phase comprising the determination of a succession of pairs of values, each comprising a value corresponding to the luminance L_{ON} of the zone in the energized state and a value corresponding to the luminance L_{OFF} of the zone in the de-energized state ;

25 - an additional phase is provided for determining the contrast (C) from the luminance values of each of said pairs ; and

30 - adjustment of the control voltage of the liquid crystal cell of the display is made as a function of the previously determined contrast.

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2. The method as claimed in claim 1, characterized in that it comprises measurement of the difference between the contrast value determined at a



time t and that determined at time $t-1$ and adjustment of the control voltage of the liquid crystal cell (1) as a function of this difference.

5 3. The method as claimed in one of claims 1 and 2, characterized in that it provides permanent self-testing of the display (1) + lighting module (2) assembly.

10 4. The method as claimed in claim 3, characterized in that it comprises the emission of an alarm signal when the value representative of the contrast is substantially equal to 1.

15 5. A device for optimizing, according to a preferential axis of vision, the contrast of a transmissive type liquid crystal display (1), in accordance with the method as claimed in claim 1, this device comprising a control circuit (4) adapted for applying, to the electrodes of the cell (1) included in a given test zone (Z), a voltage
20 causing periodic energization of the pixels included in this zone (Z), a photoelectric cell placed opposite said zone and adjustment means for adjusting the cell (1) as a function of the signal delivered by said cell, characterized in that :

25 - the photoelectric cell (8) is collimated and is oriented so as to observe the zone (Z) along a given axis (T) parallel to said preferential axis of vision (D) and deliver a luminance signal for each energized/de-energized state of said zone,

30 - the signal delivered by the photoelectric cell (8) is transmitted to a computer (5) adapted for determining a contrast value at all times from successive pairs of luminance values detected by the photoelectric cell (8),

35 - the adjustment means act on the cell (1) as a function of the contrast values thus defined, so as to obtain maximum contrast.



6. The device as claimed in claim 5,
characterized in that said photoelectric cell (8) is
disposed at the bottom of a well (13) whose opening,
5 applied against the cell (1) defines the test zone (Z).

7. The device as claimed in claim 5,
characterized in that the photoelectric cell (8) and the
optical system (9) associated therewith are mounted in a
10 variable orientation device adjustable by the user.