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Certification of Translation

Translator's Declaration: December 17, 2014

I, Mark Spahn, hereby declare:

That I possess advanced knowledge of the Japanese and English languages. My qualifications are as follows:

- over 35 years as a Japanese-English translator, focusing primarily on technical and legal documents, including four years in-house at the law offices of Baker & McKenzie in Tokyo
- Master's degree in Electrical Engineering/Computer Science from the University of Utah
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The attached translation is, to the best of my knowledge and belief, a true and accurate translation from Japanese to English of Japanese Unexamined Patent Application Number 2002-132224. I understand that willful false statements and the like are punishable by fine or imprisonment, or both (18 U.S.C. 1001), and may jeopardize the validity of the application or any patent issuing thereon. I declare under penalty of perjury that all statements made herein of my own knowledge are true, and all statements made on information and belief are believed to be true.

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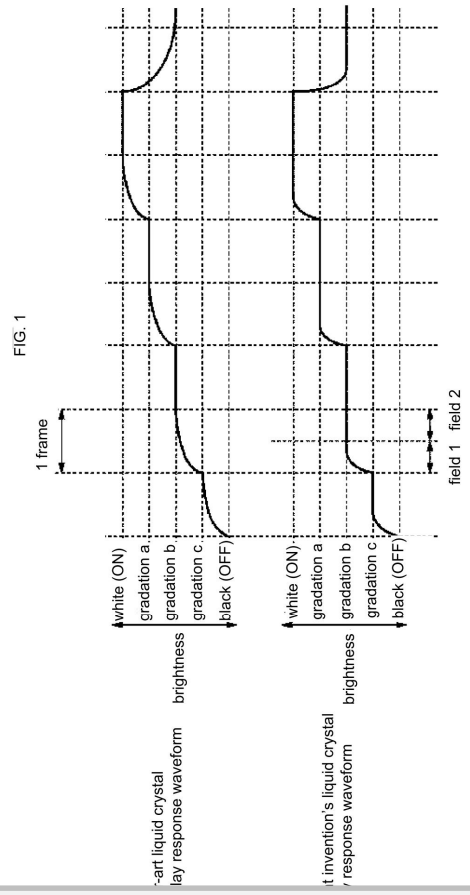
(54) **[Title of Invention] Liquid Crystal Display Device and Liquid Crystal Drive Method**

(57) **[Abstract]**
[Problem] To provide a liquid crystal drive method that can accelerate the liquid crystal response speed to 1 frame or less, and to provide a high-picture-quality, low-cost liquid crystal display device that makes use of this method.
[Means for Solving the Problems] One conventionally driven frame is divided into two fields and drive is done at double-speed drive, together with which, in the first field the display data is corrected by a predetermined conversion method, corrected display data is computed, and driving is done with the corrected display data, and in the second field driving is done with display data on which the data conversion is not carried out, whereby a response is made possible wherein, in the first field the response changes from display-OFF up to a brightness that corresponds to the converted display data (the target-reaching brightness), and in the second field this target-reaching brightness is maintained; moreover the resolution of the display data that is input is made to correspond to the resolution of the liquid crystal panel, and display is performed with the lines enlarged.

FIG. 1



[Claims]

[Claim 1] In a liquid crystal display device that has a liquid crystal panel that has multiple signal lines and multiple scan lines, a signal driver circuit that conveys to the signal lines the display voltage that corresponds to the liquid crystal display data, a scan driver circuit that conveys scan instruction signals to the scan lines, and a liquid crystal control circuit that converts display control signals (input control signals) and display data (input display data) that are supplied from outside into liquid crystal control signals and liquid crystal display data for driving the signal driver circuit and scan driver circuit,

a liquid crystal display device characterized in that: the liquid crystal control circuit has a display data conversion means that converts the input display data by a predetermined conversion method and outputs corrected liquid crystal display data;

one frame interval, which is the time for one period of the input control signal, is divided into N parts (where N is an integer greater than or equal to 2, and the interval of one division is taken to be a field); and

included in the N fields that are included in one such frame interval are fields driven with corrected liquid crystal display data that is conversion processed by the display data conversion means, and fields driven with liquid crystal display data that is not conversion processed by the display data conversion means.

[Claim 2] In the liquid crystal display device recited in claim 1, a liquid crystal display device characterized in that the liquid crystal control circuit further has:

a control signal conversion means that converts the liquid crystal control signals to be output to L-times the speed of the input control signals (where L is an integer greater than or equal to 2 and less than or equal to N); and

a display data conversion means that converts the input display data into liquid crystal display data of L-times the speed with respect to the input display data.

[Claim 3] In the liquid crystal display device recited in claim 1, a liquid crystal display device characterized in that, if the input control signal and input display data are based on interlaced video signals supplied from outside, then

the odd-number and even-number fields of the one-frame interval are each divided into N parts (one divided interval is taken to be a subfield);

included in the N subfields that are included in the odd-number fields are, for odd-number lines, fields that are driven with corrected liquid crystal display data that is conversion processed by the display data conversion means, and fields that are not liquid crystal driven; and

included in the N subfields that are included in the even-number fields are, for even-number lines, fields that are driven with corrected liquid crystal display data that is conversion processed by the display data conversion means, and fields that are not liquid crystal driven.

[Claim 4] In a liquid crystal display device as recited in any of claims 1 to 3, a liquid crystal display device characterized in that the scan driver circuit has a configuration with which multiple scan lines can be selected simultaneously.

[Claim 5] In a drive method for a liquid crystal panel that has multiple signal lines and multiple scan lines,

a liquid crystal drive method characterized in that one frame interval, which is the time for one period for displaying one screen, is divided into N parts (where N is an integer greater than or equal to 2, and the interval of one division is taken to

the scan lines are given a scan selection signal at L-times speed (where L is an integer greater than or equal to 2 and less than or equal to N); and

the signal lines in M fields (where M is an integer and M<N) are given a display voltage that corresponds to the corrected liquid crystal display data that is converted according to an L-times speed preset conversion relationship, with respect to the input display data, and in J fields (where J is an integer and is less than or equal to (N-M)) are given a display voltage that corresponds to the input display data.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs] The present invention relates to a liquid crystal display device and a drive method therefor; in particular, it concerns a liquid crystal display device drive method that can display moving pictures with high picture quality in an active matrix liquid crystal display device.

[0002]

[Prior Art] TFT liquid crystal displays, which are active matrix liquid crystal display devices, are widely used as display devices in notebook computers and other information equipment, due to their feature of being easy on the eye, in addition to their low power consumption, thinness, and light weight. But with the trend toward multimedia in recent years, upon displaying television images on a liquid crystal display, or displaying moving pictures such as playing a digital video disk (DVD), because of the slow response speed in displaying intermediate gradations, afterimages occur, and the display properties are degraded. Thus, the challenge in adapting TFT liquid crystal displays to multimedia is to solve these problems.

[0003] Making the liquid crystal response speed faster has been raised as one challenge in adapting liquid crystal display devices to moving pictures. In liquid crystal display devices that make use of liquid crystal and are usually in wide use, the response speed of the liquid crystal material is equal to or slower than the frame period of the display signal. Because of this, afterimages or moving-picture blurriness occurs in moving picture display, and adequate display performance is not obtained. For example, for a moving picture display as shown in FIG. 2 in which a circular mark (the display example in the drawing) is moved across a liquid crystal display screen, the display brightness of the liquid crystal at point A in the drawing (the chart in the lower right) lags behind the given display data (the chart in the upper right) timewise, which makes it difficult to produce a high-picture-quality moving picture display.

[0004] In light of this challenge, JP-11-044874-A discloses an example of a drive method that improves the response speed by superimposing on the display signal a signal that emphasizes changes in the display signal.

[0005]

[Problems to Be Solved by the Invention] The above prior art drive method improves the response speed of the liquid crystal, but it assumes that the signal for one-frame-interval emphasis is constant and assumes control of each individual frame. Thus the acceleration of the response speed has not been adequate, and it has been impossible to accelerate the response speed to one frame period or less.

[0006] Furthermore, because, with the above prior art method, the response speed cannot be accelerated to one frame period or less, even if the liquid crystal material is made faster and the response speed becomes equal to the frame period, if the above prior art drive method is used, the response speed actually slows down, and it has been impossible to improve the picture quality.

[0007] Furthermore, trying to accelerate the liquid crystal response speed by improving the liquid crystal material and the structure of the liquid crystal panel has been one reason why the manufacturing yield for liquid crystal panels is reduced.

[0008] The object of the present invention, which was made with the above problems in mind, is to provide a liquid crystal drive method that makes it possible for the response speed of the liquid crystal to be one frame period or less, and to provide a high-picture-quality liquid crystal display device that can be manufactured at low cost using this method.

[0009]

[Means for Solving the Problems] In order to achieve this object, in a liquid crystal display device that has a liquid crystal panel that has multiple signal lines and multiple scan lines, a signal driver circuit that conveys to the signal lines the display voltage that corresponds to the liquid crystal display data, a scan driver circuit that conveys scan instruction signals to the scan lines, and a liquid crystal control circuit that coverts display control signals (input control signals) and display data (input display data) that are supplied from outside into liquid crystal control signals and liquid crystal display data for driving the signal driver circuit and scan driver circuit, the present invention is characterized in that: the liquid crystal control circuit has a display data conversion means that converts the input display data by a predetermined conversion method and outputs corrected liquid crystal display data; one frame interval, which is the time for one period of the input control signal, is divided into N parts (where N is an integer greater than or equal to 2, and the interval of one division is taken to be a field); and included in the N fields that are included in one such frame interval are fields driven with corrected liquid crystal display data that is conversion processed by the display data conversion means, and fields driven with liquid crystal display data that is not conversion processed by the display data conversion means.

[0010] Furthermore, in the above liquid crystal display device of the present invention, the configuration is preferably such that the liquid crystal control circuit further has: a control signal conversion means that converts the liquid crystal control signals to be output to L-times the speed of the input control signals (where L is an integer greater than or equal to 2 and less than or equal to N); and a display data conversion means that converts the input display data into liquid crystal display data of L-times the speed with respect to the input display data.

[0011] Furthermore, in the above liquid crystal display device of the present invention, the configuration is preferably such that, if the input control signal and input display data are based on interlaced video signals supplied from outside, then the odd-number and even-number fields of the one-frame interval are each divided into N parts (one divided interval is taken to be a subfield); included in the N subfields that are included in the odd-number (even number) fields are, for odd-number (even number) lines, fields that are driven with corrected liquid crystal display data that is conversion processed by the display data conversion means, and fields

[0012] Furthermore, in the above liquid crystal display device of the present invention, the configuration may be such that the scan driver circuit has a configuration with which multiple scan lines can be selected simultaneously to display one line of data from the input display data on multiple lines of the liquid crystal panel.

[0013] Furthermore, in order to achieve the above object, In a drive method for a liquid crystal panel that has multiple signal lines and multiple scan lines, the present invention is characterized in that: one frame interval, which is the time for one period for displaying one screen, is divided into N parts (where N is an integer greater than or equal to 2, and the interval of one division is taken to be a field); the scan lines are given a scan selection signal at L-times speed (where L is an integer greater than or equal to 2 and less than or equal to N); and the signal lines in M fields (where M is an integer and M<N) are given a display voltage that corresponds to the corrected liquid crystal display data that is converted according to an L-times speed preset conversion relationship, with respect to the input display data, and in J fields (where J is an integer and is less than or equal to (N-M)) are given a display voltage that corresponds to the input display data.

[0014]

[Embodiments of the Invention] In the present invention, in order to accelerate the brightness response of the liquid crystal, one frame is divided timewise into multiple parts; for example, the control is such that in the first division interval (the first field) the response changes from display-OFF to a brightness that corresponds to pre-converted corrected liquid crystal display data (the target-reaching brightness), and in the second division interval (the second field), the target-reaching brightness is displayed.

[0015] Also, liquid crystal display devices often perform display having received display signals from a personal computer or the like, but such display signals have a different resolution from television signals such as NTSC signals. This is why, in a television device in which mainly moving picture display is performed, when using a liquid crystal display device instead of a CRT display device, a resolution conversion means is needed for displaying the display signals of these different resolutions in the same way.

[0016] The present invention has been given a configuration in which it controls a scan driver serving as such a resolution conversion means so that multiple scan lines can be selected simultaneously. Such a configuration makes it possible to adapt the resolution of the display data that is input to the resolution of the liquid crystal panel and to display lines enlarged.

[0017] The main modes of embodiment of the present invention are as follows.

[0018] In one mode of embodiment, the present invention is characterized in that, in a liquid crystal display device that is configured with a liquid crystal panel that has multiple signal lines and multiple scan lines that are arranged perpendicular to each other; a signal driver circuit that conveys to the signal lines, by way of write signals, the display voltage that corresponds to the liquid crystal display data; a scan driver circuit that captures leading line signals from the scan line signals and, in sequence, conveys scan instruction signals to the scan lines; and a liquid crystal control circuit that converts display control signals (input control signals) and display data (input display

data) that are supplied from a personal computer or the like into liquid crystal control signals and liquid crystal display data for driving the signal driver circuit and scan driver circuit: one frame interval, which is the time for one period of the input control signal, is divided into N parts (where N is an integer greater than or equal to 2, and the interval of one division is taken to be a field); the liquid crystal control circuit has a display data storage circuit and a display data conversion circuit; the liquid crystal control signals that are to be output are converted to L-times the speed of the input control signals (where L is an integer greater than or equal to 2 but less than or equal to N); in M fields (where M is an integer but M<N), using the display data storage circuit, a conversion is made to liquid crystal display data at N-times the speed with respect to the input display data, and in addition, with the display data conversion circuit the data is converted to corrected liquid crystal display data using a preset conversion relationship; in the remaining J fields (where J is a integer but J is less than or equal to (N-M)), the input display data, without being converted, is output unchanged as liquid crystal display data; and display is performed with the liquid crystal control signals and liquid crystal display data.

[0019] Also, in another mode of embodiment, the liquid crystal display device of the present invention is characterized in that one frame interval is divided into two parts (one divided interval is taken to be one field); the liquid crystal control circuit has a display data storage circuit and a display data conversion circuit; the liquid crystal control signals to be output are converted to twice the speed of the input control signals; in the first field, using the display data storage circuit, a conversion is made to liquid crystal display data of twice the speed with respect to the input display data, and in addition, with the display data conversion circuit, the data is converted into corrected liquid crystal display data according to a preset conversion relationship; and in the second field, the input display data, without being converted, is output unchanged as liquid crystal display data.

[0020] Also, in another mode of embodiment, the liquid crystal display device of the present invention is characterized in that one frame interval is divided into three parts (one divided interval is taken to be one field); the liquid crystal control circuit has a display data storage circuit and a display data conversion circuit; the liquid crystal control signals to be output are converted to twice the speed of the input control signals; in the first field, using the display data storage circuit, a conversion is made to liquid crystal display data of twice the speed with respect to the input display data, and in addition, with the display data conversion circuit, the data is converted into corrected liquid crystal display data according to a preset conversion relationship; in the second field, the input display data, without being converted, is output unchanged as liquid crystal display data; and in the third field, no liquid crystal driving is done.

[0021] Also, in another mode of embodiment, the liquid crystal display device of the present invention is characterized in that it receives display control signals (input control signals) and display data (input display data) that are supplied from NTSC or other interlaced video signals; the interval of the odd-number field, where odd-number display lines are supplied, and the interval of the even number field, where even-number display lines are supplied, are each divided into N parts (where N is an integer greater than or equal to 2, and one divided interval is taken to be a subfield); and the liquid crystal control circuit has a display data storage circuit and a

[0022] In addition, in the above liquid crystal display device of the present invention, which receives interlaced video signals, it is desirable that, in the above odd-number (even-number) field, for display data for odd-number (even-number) lines, the liquid crystal control signals to be output are converted to N times the speed of the input control signals; in M subfields (where M is an integer and M<N), using the display data storage circuit, a conversion is made to liquid crystal display data of N times the speed with respect to the input display data, and in addition, with the display data conversion circuit, with the data, conversion is made to corrected liquid crystal display data according to a preset conversion relationship; in J subfields (where J is an integer and is less than or equal to (N-M)), no liquid crystal driving is done; for the display data of even-number (odd-number) lines, the liquid crystal control signals to be output are converted to N times the speed of the input control signals; using the display data storage circuit, in M subfields (where M is an integer and M<N) a conversion is made to liquid crystal display data of N times the speed with respect to the input display data, and input display data is output unchanged as liquid crystal display data without being converted; and in the remaining (N-M) subfields, no liquid crystal driving is done.

[0023] Also, in another mode of embodiment, the liquid crystal display device of the present invention receives display control signals (input control signals) and display data (input display data) supplied from NTSC or other interlaced video signals; the interval of odd-number fields and of even-number fields is divided into three parts (one divided interval is taken to be a subfield); and the liquid crystal control circuit has a display data storage circuit and a display data conversion circuit.

[0024] Here, in the odd-number (even-number) fields, for the display data of an odd-number (even-number) line, the liquid crystal control signals to be output are converted to three times the speed of the input control signals; in one subfield a conversion is made to liquid crystal display data of three times the speed with respect to the input control signals, and in addition, with the data, a conversion is made to corrected liquid crystal display data according to a preset conversion relationship; in one field, the input display data is not converted and is output unchanged as liquid crystal display data while in the remaining one field no driving is done; for the display data of even-number (odd-number) lines, the liquid crystal control signals to be output are converted to three times the speed of the input control signals; in one subfield, a conversion is made to liquid crystal display data of three times the speed with respect to the input display data, and the input display data is output unchanged as liquid crystal display data without being converted; and in the remaining two fields, no liquid crystal driving is done.

[0025] Also, in the liquid crystal display device of the present invention in each of the above modes of embodiment, the configuration may be such that the scan driver circuit selects multiple scan lines simultaneously and one line of data from the input display data is displayed on multiple lines of the liquid crystal panel.

[0026] Also, in another mode of embodiment, the present invention has multiple signal lines and multiple scan lines, and is characterized in that, in a liquid crystal drive method in which display is performed by conveying to the signal lines the display voltage that corresponds to the liquid crystal display data while conveying scan instruction signals to the scan lines, in sequence, beginning with the leading line; one

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