

Monitor Geometry Correction Circuit and Method

Field of the Invention

This invention relates to a circuit for correcting monitor
5 display geometry and to a method thereof, and particularly to a
digital circuit and method for correcting monitor display geometry.

Background of the Invention

As is well known, monitors are primarily used as displays for
computers, although they can also be used for television. There are
10 a number of different standard modes in which monitors are
required to operate, for example VGA, SVGA, XVGA, etc, in which the
resolution, and hence the number of lines scanned across the screen
of the Cathode Ray Tube (CRT) of the monitor varies.

Due to the physical properties of the CRT, the lines do not scan
15 correctly in a rectangular shape on the screen. In particular, as is
known, there are a number of corrections that have to be made to
compensate for the irregularities. For example, there is a parabolic
correction, a trapezoidal correction and a corner correction, all of
which form part of a correction signal which is applied to influence
20 the horizontal scan lines in order to improve the display quality on
the screen, especially in the corners.

With digital signal processing, the correction signal Y can be
expressed as a polynomial function of time:

$$Y = b_0 + b_1.t + b_2.t^2 + b_3.t^3 + \dots + b_n.t^n$$

25 where t is the vertical timing relative to the vertical synchronisation
pulse at the beginning of each vertical frame; and
b_i are predetermined coefficients.

However, although such a digital correction output signal can
be calculated relatively easily by a Digital Signal Processor (DSP), the
30 coefficients b_i need to be predetermined and they will vary for
different display size and position settings and each of the different
modes in which the monitor must be able to operate.

To make the coefficients b_i independent of display size and
position and video mode being used, the correction signal can be
35 made a function of the actual vertical position x on the screen:

$$Y = a_0 + a_1.x + a_2.x^2 + a_3.x^3 + \dots + a_n.x^n$$

Although different methods can be utilised to determine the value of x , they usually require a precision which can necessitate utilising complicated and/or expensive components or circuitry. For example, x can be determined by utilising the current in the CRT yoke, but this would require a very accurate analog-to-digital converter (ADC), which is expensive.

Brief Summary of the Invention

The present invention therefore seeks to provide a monitor geometry correction circuit and method which overcomes, or at least reduces the above-mentioned problems of the prior art.

Accordingly, in a first aspect, the invention provides a monitor geometry correction circuit comprising a correction signal calculating circuit coupled to a position determining circuit, the position determining circuit including a counter for counting horizontal scan lines of a monitor display and providing a count value at an output thereof, a store for storing a total number of scan lines in a vertical frame of the display and a position calculating circuit coupled to the output of the counter and the store for calculating the actual position in the vertical frame that has been reached and providing an output signal indicative thereof, the correction signal calculating circuit receiving the output signal and calculating a monitor geometry correction signal based thereon.

In a preferred embodiment, the counter comprises a count input for receiving a horizontal synchronization signal from a monitor horizontal driver circuit and the counter counting the number of pulses in the horizontal synchronization signal to provide the count value, the counter further comprising a reset input for receiving a vertical synchronization signal from a monitor vertical driver circuit and resetting the count value when a vertical synchronisation pulse is received.

Preferably, the counter is coupled to an input of the store for outputting its count value to the store when the vertical synchronisation pulse is received, but before the count value is reset.

The position calculating circuit preferably has inputs for receiving one or more user adjusted values for adjusting the output signal.

In one preferred embodiment, the correction signal calculating circuit comprises a Digital Signal Processor for calculating the monitor geometry correction signal Y using the expression:

$$Y = a_0 + a_1.x + a_2.x^2 + a_3.x^3 + \dots + a_n.x^n$$

- 5 where x is the actual position provided by the output signal from the position determining circuit; and
a_i are predetermined coefficients.

In a second aspect, the invention provides a method of calculating a monitor geometry correction signal as a function of
10 vertical position on a monitor display screen, the method comprising the steps of:

counting horizontal scan lines of a monitor display to provide a count value;

15 storing a total number of scan lines in a vertical frame of the display;

calculating the actual position in the vertical frame that has been reached to provide an output signal; and

calculating a monitor geometry correction signal based on the output signal.

20 Brief Description of the Drawings

One embodiment of the invention will now be more fully described, by way of example, with reference to the drawings, of which:

FIG. 1 shows how an uncorrected display on a CRT screen;

25 FIG. 2 shows a display similar to that of FIG. 1, but corrected by a correction signal as a function of time;

FIG. 3 shows the relationship between a vertical synchronisation, a vertical drive and the correction signals;

30 FIG. 4 shows a reduced vertical size display, when corrected by the correction signal;

FIG. 5 shows a display similar to that of FIG. 4, but corrected by a correction signal as a function of vertical size;

35 FIG. 6 shows the relationship between a vertical synchronisation, a vertical drive and the correction signals as functions of both time and vertical size; and

FIG. 7 shows a schematic block diagram of the monitor geometry correction circuit according to one embodiment of the present invention.

Detailed Description of the Drawings

5 Thus, as shown in FIG. 1, the actual display 2 on the screen of a CRT 1 does not usually appear as a true rectangular shape if geometry correction is not made. Due to the physical properties of the CRT 1, the lines do not scan correctly in a rectangular shape on the screen leading to the "barrel" shaped display 2. If a proper
10 geometry correction is made, then the display 3 on a CRT 4 can be corrected to a good rectangular shape as shown in FIG. 2. There are a number of corrections that are commonly made to compensate for the irregularities. For example, there is a parabolic correction, a trapezoidal correction and a corner correction, all of which form part
15 of a correction signal Y which is applied to influence the horizontal scan lines in order to improve the display quality on the screen. As shown in FIG. 3, the correction signal Y(t), shown as waveform 7, is usually synchronized with a vertical drive signal (HDRIVE), shown as waveform 6, which drives the vertical yoke of the CRT. The vertical
20 drive signal (HDRIVE) is, in turn, synchronized with a vertical synchronization pulse (VSYNC), shown as waveform 5, which is generated from a display control circuit in the computer, such as by VGA, SVGA cards.

Utilising digital signal processing, the correction signal Y can be
25 expressed as a polynomial function of time:

$$Y(t) = b_0 + b_1.t + b_2.t^2 + b_3.t^3 + \dots + b_n.t^n$$

where t is the vertical timing relative to the vertical synchronisation pulse at the beginning of each vertical frame; and b_i are predetermined coefficients.

30 As mentioned above, although such a digital correction output signal Y(t) can be calculated relatively easily by a Digital Signal Processor (DSP), the coefficients b_i which need to be predetermined will vary for different display size and position settings and each of the different video display modes in which the monitor must be able
35 to operate. FIG. 4 shows a display 8 on a CRT 9 which has been initially properly corrected by the correction signal Y(t) for a normal vertical display size and then changed to a smaller vertical display

size. It will be apparent that the correction required in the corners of a display utilising the full size of the screen is different from that required for a display utilising a reduced size on the screen. Thus, in order to make the coefficients independent of display size and position and video mode being used, the correction signal is made a function of the actual physical vertical position x on the screen:

$$Y(x) = a_0 + a_1.x + a_2.x^2 + a_3.x^3 + \dots + a_n.x^n$$

For example, the total screen height can be defined to be a value of 1, with the centre being defined as 0, so that at the top of the screen $x = -0.5$ and at the bottom of the screen $x = 0.5$. Once the correction signal Y is made a function of physical vertical position x on the CRT screen, the coefficients are independent of display size, position and video mode being used. FIG. 5. shows a reduced size display 10 on a CRT 11 when corrected by such a correction signal $Y(x)$. FIG. 6 shows the relationship between the waveform 12 of the VSYNC signal, the waveform 13 of the VDRIVE signal, the waveform 14 of the correction signal as a function of time $Y(t)$ and the correction signal when it is made a function of physical vertical position $Y(x)$.

Thus, a method of determining the value x by counting the number of horizontal scan lines is provided. This method is based on an assumption that when the vertical display size and position are set at default values, the 1st scan line in a vertical frame is at the top of the screen where $x = -0.5$, and the last scan line is at the bottom of the screen where $x = 0.5$. Although, this assumption is reasonably acceptable, the first few scan lines may appear in vertical retrace period which are not visible, but in general this causes only negligible effect.

FIG. 7 shows a block diagram of a monitor geometry correction circuit for determining the value of x , and generation of the correction signal $Y(x)$. A digital counter 16 is used to count the number of horizontal lines. It is reset at the leading edge of each pulse of the vertical synchronization (VSYNC) signal, input at terminal 17, and advanced by one thereafter at the leading edge of each pulse of a horizontal synchronization (HSYNC) signal input at terminal 18. The value in counter 16, count " n ", denotes the current scan line number in a vertical frame. When counter 16 reaches the

end of a vertical frame, i.e., at the next leading edge of the VSYNC signal, the counter output n is incremented by 1 by an incrementer logic circuit 19 and then loaded into a register 20 before counter 16 is cleared by the VSYNC signal. Thus, the value "N" in the register 20
5 denotes the total number of scan lines in a vertical frame.

The physical vertical location x can then be calculated by doing dividing, multiplying, subtracting and adding operations over the values "n", "N" and the two user adjustable parameters: vertical size (Vs) and vertical center (Vc), which are input at terminals 21 and
10 22, respectively. This calculation can be implemented either by hardware or combination of hardware and software. For example, in this embodiment, a calculation block 23 is arranged to receive the value "N" from the register 20 at one input, the value "n" from counter 16 at another input and the user adjustable parameters
15 from terminals 21 and 22 at further inputs, in order to calculate the physical vertical position x using the formula :

$$x = (n/N-0.5)*Vs+Vc$$

20 where the total screen height is defined to be a value of 1, with the centre being defined as x=0, so that at the top of the screen x = -0.5 and at the bottom of the screen x = 0.5x=-0.5, where the default value for Vs is 1, and Vc is 0.

The calculation is done on a line by line basis, so that the value
25 of x which is calculated by the calculation block 23 actually represents the physical vertical position of current scan line. By feeding x to a geometry correction block 24, which generates the correction signal Y(x) based on the physical vertical position x, the correction signal Y(x) as a function of physical vertical position of
30 the CRT can be generated. It will be appreciated that the geometry correction block 24, which could be, for example, a DSP, calculates the polynomial

$$Y(x) = a_0 + a_1.x + a_2.x^2 + a_3.x^3 + + a_n.x^n$$

in a known manner to produce the correction signal Y(x). Therefore,
35 the coefficients a_i are independent of display size and position and the particular video mode being used once they have been initially determined and stored.

It will be appreciated that although only one particular embodiment of the invention has been described in detail, various modifications and improvements can be made by a person skilled in the art without departing from the scope of the present invention.



Claims

1. A monitor geometry correction circuit comprising a correction
signal calculating circuit coupled to a position determining circuit,
5 the position determining circuit including a counter for counting
horizontal scan lines of a monitor display and providing a count
value at an output thereof, a store for storing a total number of scan
lines in a vertical frame of the display and a position calculating
circuit coupled to the output of the counter and the store for
10 calculating the actual position in the vertical frame that has been
reached and providing an output signal indicative thereof, the
correction signal calculating circuit receiving the output signal and
calculating a monitor geometry correction signal based thereon.
- 15 2. A monitor geometry correction circuit according to claim 1,
wherein the counter comprises a count input for receiving a
horizontal synchronization signal from a monitor horizontal driver
circuit and the counter counting the number of pulses in the
horizontal synchronization signal to provide the count value, the
20 counter further comprising a reset input for receiving a vertical
synchronization signal from a monitor vertical driver circuit and
resetting the count value when a vertical synchronisation pulse is
received.
- 25 3. A monitor geometry correction circuit according to claim 2,
wherein the counter is coupled to an input of the store for
outputting its count value to the store when the vertical
synchronisation pulse is received, but before the count value is
reset.
- 30 4. A monitor geometry correction circuit according to any
preceding claim, wherein the position calculating circuit having
inputs for receiving one or more user adjusted values for adjusting
the output signal.
- 35 5. A monitor geometry correction circuit according to any
preceding claim, wherein the correction signal calculating circuit



comprises a Digital Signal Processor for calculating the monitor geometry correction signal Y using the expression:

$$Y = a_0 + a_1.x + a_2.x^2 + a_3.x^3 + \dots + a_n.x^n$$

where x is the actual position provided by the output signal from the position determining circuit; and
a_i are predetermined coefficients.

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6. A method of calculating a monitor geometry correction signal as a function of vertical position on a monitor display screen, the method comprising the steps of:
 - counting horizontal scan lines of a monitor display to provide a count value;
 - storing a total number of scan lines in a vertical frame of the display;
 - calculating the actual position in the vertical frame that has been reached to provide an output signal; and
 - calculating a monitor geometry correction signal based on the output signal.
7. A method of calculating a monitor geometry correction signal according to claim 6, wherein the step of counting comprises:
 - receiving a horizontal synchronization signal from a monitor horizontal driver circuit and counting the number of pulses in the horizontal synchronization signal to provide the count value; and
 - receiving a vertical synchronization signal from a monitor vertical driver circuit and resetting the count value when a vertical synchronisation pulse is received.
8. A method of calculating a monitor geometry correction signal according to claim 7, wherein the step of calculating the actual position comprises receiving one or more user adjusted values for adjusting the output signal.
9. A method of calculating a monitor geometry correction signal according to any one of claims 6, 7 or 8, wherein the step of calculating the monitor geometry correction signal Y involves calculating the expression:



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$$Y(x) = a_0 + a_1 \cdot x + a_2 \cdot x^2 + a_3 \cdot x^3 + \dots + a_n \cdot x^n$$

where x is the actual position provided by the output signal; and a_i are predetermined coefficients.