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VIDEO SPECIAL EFFECTS GENERATORS

This invention relates to video special effects generators.

5 A video special effects generator has been proposed by which an original video image can be rotated, enlarged, reduced and moved on a picture screen of a television monitor in a three-dimensional (3D) fashion.

10 In this previously proposed video special effects generator, an original video image 11 shown on the left-hand side in Figure 1 is converted into digital data, and stored in a frame memory (not shown). In accordance with processing of the original video image, for example image rotation processing, the read address of the frame memory, that is, the address in the frame memory corresponding to the display address on the display screen is calculated in a real-time fashion, and the original video image data are read out from the frame memory
15 in accordance with the read address resulting from the calculation. Thereafter, the video image data read out from the frame memory are converted into analogue form and displayed on the display screen, so that a rotation-processed video image 12 is displayed on a display
20 screen 13 as shown at the right-hand side in Figure 1.

In this video special effects generator, in order to display the original video image 11 that is processed to be rotated in a three-dimensional manner, address calculations must be performed to determine the location of coordinates of the display screen 13
25 relative to the coordinates of the rotation-processed video image.

Thereafter, if the image to be displayed on the display screen 13 comprises a portion smaller than the original video image 11, that is, a reduced image, then the calculation of the coordinates of the location of the rotated image becomes very difficult. For
30 example, assuming that a point α of the original video image 11 represents an origin, then a point β on the display screen 13 has a negative value relative to the processed video image 12, and a point γ on the display screen 13 has a much larger value. Thus, the coordinate system of the whole display screen 13 has a large dynamic
35 range. Therefore, in order to calculate all of the coordinates of the display screen 13 in real time fashion, it is necessary to use a very complicated and expensive calculating circuit.

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According to the present invention there is provided a special effects generator for video signals, the generator comprising: memory means for storing video signals;
a source of data indicating a calculating region for a special effects
5 pattern;
generating means coupled to said memory means and said source of data for generating a read address for addressing said video signals stored in said memory means associated with the special effect pattern; and
10 address generation control means coupled to said source of data and to said generating means for limiting the generation of said read address in response to the data indicating the calculating region from said source of data.

Thus an embodiment of special effects generator according to the present invention for processing video signals comprises a memory
15 for storing incoming video signals, a read address generating circuit coupled to the memory for generating a read address to be supplied to the memory, and an address generation control circuit coupled to the read address generating circuit for limiting the operation of the read address generating circuit.

20 The invention will now be described by way of example with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Figure 1 shows schematic representations of an original video image and a rotation-processed video image;

25 Figure 2 is a block diagram of an embodiment of special effects generator for video signals according to the present invention;

Figure 3 shows a schematic representation of a video image processed by the embodiment of Figure 2; and

30 Figure 4 is a schematic representation used in explaining the operation of the embodiment.

Referring to Figure 2, the embodiment comprises a central processing unit (CPU) 1 that is coupled to a read only memory (ROM) 2 and other circuit elements, which will be described later, via a bus
35 line BL. The ROM 2 has stored therein data that indicate the calculating region for each special effects pattern on the display screen.



More specifically, as shown in Figure 3, the ROM 2 has stored therein a calculation region start address S_x in the lateral direction (x-axis direction) of the display screen 13, an end address E_x in the same direction, a calculation region start address S_y in the longitudinal direction (y-axis direction) of the display screen 13, and an end address E_y in the same direction, thereby to specify a calculation region 14.

There is shown in Figure 2 a calculation region control circuit 3 that includes registers RXS , RXE , RYS and RYE . The register RXS stores the calculation region start address S_x , and the register RXE stores the end address E_x . The register RXS stores the start address S_y , and the register RYE stores the end address E_y .

As shown in Figure 2, counters CX and CY are provided. The counter CX is reset by a horizontal synchronizing signal (H), and counts clock pulses that correspond to pixels along a horizontal scan line continuously to generate an address X_s in the x-axis direction of the display screen 13, whereas the counter CY is reset by a vertical synchronizing signal (V), and counts horizontal synchronizing signals (H) continuously to generate an address Y_s in the y-axis direction of the display screen 13. Therefore, the counter CY and CX continuously count changing x-axis and y-axis addresses.

Comparators $COM1$ and $COM2$ are provided, which are both coupled to the counter CX , and the comparator $COM1$ compares the x-axis direction address X_s from the counter CX with the calculation region start address S_x from the register RXS . The comparator $COM1$ derives an output signal "1" when the address X_s from the counter CX is larger than the start address S_x . The comparator $COM2$ compares the x-axis direction address X_s from the counter CX with the end address E_x from the register RXE . When the address X_s from the counter CX is smaller than the end address E_x , the comparator $COM2$ derives an output signal "1".

Comparators $COM3$ and $COM4$ are also provided, which are both connected to the counter CY . The comparator $COM3$ compares the y-axis direction address Y_s from the counter CY with the start address S_y from the register RYS . When the address Y_s from the counter CY is larger than the start address S_y , the comparator $COM3$ derives an output signal "1". The comparator $COM4$ compares the y-axis direction



address Y_s from the counter CY with the end address E_y from the register RYE. When the address Y_s from the counter CY is smaller than the end address E_y , the comparator COM4 derives an output signal "1". AND circuits AND1 and AND2 are coupled to the comparators COM1 and COM2, and COM3 and COM4 respectively. The AND circuit AND1 is supplied at input terminals thereof with the signals from the comparators COM3 and COM4.

The output signals from the AND circuits AND1 and AND2 are supplied to a read address calculating circuit 4 as addresses X_R and Y_R to limit the region of the calculating operation for the read address calculating circuit 4, so that the read address calculating circuit 4 is inhibited from performing useless calculations. Moreover, the output signal of the counter CX is supplied to the read address calculating circuit 4 as an address X_s and the output signal of the counter CY is also supplied thereto as an address Y_s .

The read address calculating circuit 4 calculates read addresses X_L and Y_L to read the data from a frame memory 7 in a fixed decimal point calculation fashion. The read address calculating circuit 4 also generates a key signal KEY that indicates a border line in the processed video image 12.

In Figure 2, there are also provided an analogue-to-digital (A/D) converting circuit 6 and a digital-to-analogue (D/A) converting circuit 8.

An analogue video signal of an original video image is applied to an input terminal 5 and is fed to the A/D converting circuit 6, in which it is converted to the form of a digital signal. The digital signal from the A/D converting circuit 6 is supplied to the frame memory 7. The frame memory 7 supplies the digital signal to the D/A converting circuit 8 in accordance with the address signals X_L and Y_L from the read address calculating circuit 4. The D/A converting circuit 8 is gated by a gate circuit 9 in response to the key signal (KEY) from the read address calculating circuit 4, and an output signal from the gate circuit 9 is fed to an output terminal 10.

The process of rotating the original video image will be described with reference to Figure 4.

As shown in Figure 4, an x axis extends in the horizontal direction on the display screen 13, a y axis extends in the vertical



direction on the display screen 13, a z axis extends in the direction perpendicular to the display screen 13, ζ is the rotational angle about the x axis, θ is the rotational angle about the z axis. X_s is the address in the x-axis direction on the display screen 13, Y_s is the address in the y-axis direction on the display screen 13, and X_L and Y_L are the read addresses to the frame memory 7. Then, the read addresses X_L and Y_L are given by the following equations:

$$X_L = - \{ (R_4 X_s - R_1 Y_s) Z_0 \} m / \{ R_2 X_s + R_5 Y_s + R_8 (Z_s - Z_0) \} \quad \dots\dots\dots(1)$$

$$Y_L = - \{ (R_3 X_s - R_0 Y_s) Z_0 \} n / \{ R_2 Y_s + R_5 Y_s + R_8 (Z_s - Z_0) \} \quad \dots\dots\dots(2)$$

where Z_0 and Z_s are constants, and m and n are coefficients used to enlarge or reduce the original video image. Moreover, in equations (1) and (2), R_0 to R_8 are constants depending on the rotational angles ζ , θ and $\emptyset$, and the order of the rotations around the rotational axes. If the video image is rotated in the order of, for example, about the x axis, about the y axis and about the z axis, the constants R_0 to R_8 are expressed by the following equation:

$$\begin{bmatrix} R_0, R_3, R_6 \\ R_1, R_4, R_7 \\ R_2, R_5, R_8 \end{bmatrix} = \begin{bmatrix} \cos \theta \cos \emptyset, \cos \theta \sin \emptyset, & -\sin \theta \\ \sin \zeta \sin \theta \cos \emptyset - \cos \zeta \sin \emptyset, \sin \zeta \sin \theta \sin \emptyset + \cos \zeta \cos \emptyset, \sin \zeta \cos \theta \\ \cos \zeta \sin \theta \cos \emptyset + \sin \zeta \sin \emptyset, \cos \zeta \sin \theta \sin \emptyset \sin \zeta \cos \emptyset, \cos \zeta \cos \theta \end{bmatrix} \quad \dots\dots\dots(3)$$

Equations (1) to (3) are executed by the read address calculating circuit 4. For example, the read address calculating circuit 4 calculates the constants R_0 to R_8 by means of equation (3) in accordance with the angle information ζ , θ and $\emptyset$ from the CPU 1. The constants R_0 to R_8 thus obtained, and constants Z_0 , Z_s , m and n are substituted into equations (1) and (2), and then the read addresses X_L and Y_L are calculated by the read address calculating circuit 4. Thereafter, the data at the addresses X_L and Y_L are supplied to the frame memory 7. Then the data at the addresses X_L and Y_L are supplied from the frame memory 7 to the D/A converting circuit 8, thereby converting into an analogue signal an image of a rotation-processed video signal. Thus, the processed video image 12 shown in



Figure 3 is displayed on the display screen 13.

As described above, since the calculation for processing the original video image in a special effects fashion is limited to the calculation region 14 within which the processed video image 12 is displayed on the display screen 13, the dynamic range of the coordinate system on which the calculation is made is small, and the number of figures necessary for the calculation is made is small. Therefore, the circuits for the calculation are simple in arrangement and are inexpensive, thus making it possible to realize an inexpensive special effects generator having multiple functions.

While data showing the calculation region 14 of each special effect pattern are stored in the ROM 2 as described above, data for each calculating region 14 need not be stored in advance but may be calculated by the CPU 1 for each special effects pattern that is desired.

The calculations for the calculating region 14 can be performed either by software or hardware. Furthermore, the calculation for obtaining the addresses X_L and Y_L may be performed in a fixed or a floating decimal point calculation fashion.



CLAIMS

1. A special effects generator for video signals, the generator comprising:
5 memory means (7) for storing video signals;
a source (2) of data indicating a calculating region (14) for a special effects pattern;
generating means (4) coupled to said memory means (7) and said source (2) of data for generating a read address for addressing said video
10 signals stored in said memory means (7) associated with the special effects pattern; and
address generation control means coupled to said source (21) of data and to said generating means (4) for limiting the generation of said read address in response to the data indicating the calculating region
15 (14) from said source (2) of data.
2. A special effects generator according to claim 1 wherein said address generation control means receives the data indicating the calculating region (14) for the special effects pattern from said
20 source (2) of data, and includes x address limited means for producing an x address limiting signal fed to said read address generating means (14), and y address limiting means for producing a y address limiting signal fed to said read address generating means (4).
- 25 3. A special effect generator according to claim 2 wherein said x address limiting means includes a first register (RXS) for setting an x start address, a second register (RXE) for setting an x end address, a first comparator (COM1) being supplied with said x start address stored in said first register (RXS), a second comparator
30 (COM2) being supplied with said x end address set in said second register (RXE), a first counter (CX) receiving synch signals of said video signals and for supplying an x display address to said first and second comparators (COM1, COM2), said first comparator (COM1) comparing said x start address with said x display address and
35 generating a signal when said x display address is larger than said x start address, and said second comparator (COM2) comparing said x end address with said x display address and generating a signal when said





x display address is smaller than said end address, while said y address limiting means includes a third register (RYS) for setting a y start address, a fourth register (RYE) for setting a y end address, a third comparator (COM3) supplied with said y start address set in said third register (RYS), a fourth comparator (COM4) being supplied with said y end address set in said fourth register (RYE), and a second counter (CY) receiving synch signals of said video signals and for supplying a y display address to said third and fourth comparators (COM3, COM4), said third comparator (COM3) comparing said y start address with said y display address and generating a signal when said y display address is larger than said y start address, and said fourth comparator (COM4) comparing said y end address with said y display address and generating a signal when said y display address is smaller than said y end address.

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4. A special effects generator according to claim 3 wherein said x address limiting means further includes a first AND gate (AND1) coupled to said first and second comparators (COM1, COM2) for generating said x address limiting signal to be supplied to said read address generating means (4), and said y address limiting means further includes a second AND gate (AND2) coupled to said third and fourth comparators (COM3, COM4) for generating said y address limited signal to be supplied to said read address generating means (4).

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5. A special effects generator according to claim 4 wherein said x display address from said first counter (CX) and said y display address from said second counter (CY) are also supplied to said read address generating means (4).

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6. A special effects generator according to claim 1 further comprising gating means (9) coupled to said memory means (7) and said generating means (4) for passing said video signals respectively associated with said special effects through said gating means (9) in response to a key signal formed by said generating means (4) and representing a border of an image in the video signals.

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