

COLOUR SEPARATION AND CONTOUR CORRECTION

The present invention relates to circuits for colour separation and contour correction, and may be applied to video cameras.

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A known chrominance signal processing method is an analog processing method and uses two 1H delay elements respectively for colour separation and contour correction.

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Since a total of four delay elements are used, the circuit is relatively complicated.

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Preferred embodiments of the present invention aim to solve the above-mentioned problem by providing a circuit which can perform colour separation and contour correction specifically utilizing two 1H delay elements.

According to one aspect of the present invention, there is provided a circuit for colour separation and contour correction, comprising:

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delay means for outputting 1H delayed and 2H delayed chrominance signals;

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first adding means for adding the 2H-delayed chrominance signal from the delay means to a currently-input chrominance signal;

amplifying means for amplifying the output of the first adding means;

chrominance signal separation means for separating the chrominance signals of colour components from the output of the amplifying means and the 1H delayed chrominance signal from the delay means;

5 contour correcting means for generating vertical and horizontal contour correcting signals in response to the output of the 1H delayed chrominance signal from the delay means and the output of the amplifying means; and

10 second adding means for adding the vertical and horizontal contour correcting signals output from the contour correcting means to the 1H delayed chrominance signal thereby to output a luminance signal which has been corrected in contour,

wherein said chrominance signal separation means comprises:

15 a colour integrating portion for integrating the chrominance signal output from the amplifying means and the 1H delayed chrominance signal from the delay means;

20 a sample-and-hold portion for sampling an identical chrominance signal portion from the chrominance signal output from the colour integrating portion thereby to keep outputting the same;

25 a subtracter for extracting red and blue components of chrominance signals in response to the signals output from the output of the sample-and-hold portion; and

an adder for generating a luminance signal in response to the signals output from the output of the sample-and-hold portion.

Preferably, said contour correcting means comprises:

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a vertical contour correcting portion for generating a vertical contour correcting signal from the 1H delayed chrominance signal from the delay means and the chrominance signal output from the amplifying means;

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a horizontal contour correcting means for generating a horizontal contour correcting signal from the 1H delayed chrominance signal the delay means;

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an adder for adding the horizontal contour correcting signal output from the horizontal contour correcting portion and the vertical contour correcting signal output from the vertical contour correcting portion; and

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an aperture compressor for compressing the vertical and horizontal contour correcting signals output from the adder.

Preferably, said amplifying means has a gain of 0.5.

Preferably, said colour components are red and blue components.

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The invention extends to a video camera provided with a circuit according to any of the preceding aspects of the invention.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

5 Figure 1 is a circuit diagram of one example of a circuit for colour separation and contour correction in accordance with the present invention;

Figure 2 is a constructional drawing of a conventional CCD image sensor;

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Figure 3 is a component drawing of an output signal from the CCD image sensor shown in Figure 1;

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Figures 4 - 8 are component drawings of examples of respective output signals from the circuit of Figure 1;

Figure 9 is a timing diagram of a colour separating signal illustrated in Figure 1;

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Figure 10 is a detailed constructional drawing of a horizontal contour correcting means 7 illustrated in Figure 1; and

Figures 11A - 11F are output timing diagrams relating to Figure 10.

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The circuit for colour separation and contour correction which is illustrated in Figure 1 is for use in a video digital camera which converts a chrominance signal input from a CCD (Charge Coupled Device) image sensor to a digital signal to thereafter be processed.

In Figure 1, an input IN which came from the CCD image sensor and thereafter was changed to a digital signal is supplied to a 1H delay means 1 and adding means 3. Meanwhile, a complementary colour filter is attached to each pixel in the CCD image sensor, the construction of which is illustrated in Figure 2.

In other words, a first horizontal line has an arrangement of G (Green), Mg (Magenta), G, Mg, in that order.

10 A second horizontal line has an arrangement of Cy (Cyan), Ye (Yellow), Cy, Ye, in that order.

A third horizontal line has an arrangement of Mg, G, Mg, G, Mg, G, in that order.

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In the CCD image sensor, an arrangement as described in the foregoing is repeated every fourth horizontal line.

20 At this point, the chrominance signals R (Red), G (Green), B (Blue) are made by adding pixels of 2 horizontal lines from the CCD image sensor.

In other words, in OH, a chrominance signal is formed in the order of G+Cy, Mg+Ye, G+Cy, Mg+Ye and in 1H, a chrominance signal is formed in the order Mg+Cy, G+Ye, Mg+Cy, G+Ye

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This kind of arrangement of chrominance signal is repeated.

At this point, because $Mg=R+B$, $CY=G+B$ and $Ye=R+G$, the chrominance signal output from the CCD image sensor having an arrangement as illustrated in Figure 2 can be depicted as shown in Figure 3. Namely, OH has an order of $2G+B$, $2R+B+G$, $2G+B$, $2R+B+G$

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Meanwhile, 1H has an order of $R+2B+G$, $2G+R$, $R+2B+G$, $2G+R$,, and 2H has an order of $2G+B$, $2R+B+G$, $2G+B$, $2R+B+G$,, just like OH.

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Accordingly, the chrominance signal input to 1H delay means 1 and adding means 3 illustrated in Figure 1 is the same as is shown in Figure 3.

The chrominance signal as depicted in Figure 3 is delayed for 1H period at 1H delay means 1 to thereafter be output.

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The chrominance signal output from the 1H delay means 1 is once again delayed for a 1H period at 1H delay means 2.

20 Therefore, when OH chrominance signal of Figure 3 is output from the delay means 2, 1H chrominance signal of Figure 3 is output from 1H delay means 1 and 2H chrominance signal is input to the input terminal IN.

25 When the above is viewed on the same time zone (t_1 , t_2 , t_3 ), an input IN, an output a of 1H delay means 1 and an output b of 2H delay means 2 can be depicted respectively as per Figures 4, 5, and 6.

The adding means 3, as illustrated in Figure 4, adds an input chrominance signal to a chrominance signal output from 1H delay means 2 as illustrated in Figure 6.

5 Amplifying means 4 decreases by half the level of chrominance signal added from the adding means 3.

Accordingly, an output of the amplifying means 4 is just like the chrominance signal as illustrated in Figure 4 (which is identical to Figure 6),
10 which is executed to remove noise by adding two correlated horizontal lines to thereafter decrease by half.

The chrominance signal wherein the noise is removed by the adding means 3 and amplifying means 4 is supplied to contour correcting means 10
15 and chrominance signal separation means 30.

Likewise, a chrominance signal as supplied to the input terminal IN as illustrated in Figure 4 is delayed for a 1H period at 1H delay means 1 as illustrated in Figure 5 and then supplied to the contour correcting means 10
20 and chrominance signal separation means 30.

The contour correcting means 10 generates horizontal and vertical contour correcting signals by utilizing the chrominance signal output from the amplifying means 4 as illustrated in Figure 4 and the chrominance signal
25 output a from the 1H delay means as illustrated in Figure 5.

In other words, a vertical contour correcting portion 6 of the contour correcting means 10 generates the vertical contour correcting signal by

utilizing the chrominance signal output from the amplifying means 4 and the chrominance signal output from the 1H delay means 1.

5 A horizontal contour correcting portion 7 generates the horizontal contour correcting signal by utilizing the chrominance signal output from the 1H delay means 1.

10 The horizontal and vertical contour correcting signals generated from the horizontal contour correcting portion 6 and vertical contour correcting portion 7 are supplied to an adder 8 thereby to be added.

15 At this moment, the output signal output from the adder 8 is a signal which includes the horizontal contour correcting signal and vertical contour correcting signal.

An aperture compressor 9 compresses and thereafter outputs the vertical and horizontal contour correcting signals output from the adder 8.

20 At this point, the aperture compressor 9 adjusts and outputs a clip level and an output level in order that the contour correcting signals can be mixed by as much as is needed.

25 The adding means 5 mixes and outputs the chrominance signal output from the 1H delay means 2 and the contour correcting signal output from the aperture compressor 9 of the contour correcting means 10.

The output of the adding means 5 is input to a luminance system to thereafter be processed.

Meanwhile, the chrominance signal separation means 30 generates a chrominance signal Cr of R component, a chrominance signal Cb of B component and a luminance signal Y1 by utilizing the chrominance signal output from the amplifying means 4 as illustrated in Figure 4 and the chrominance signal output from the 1H delay means 1 as illustrated in Figure 5.

A detailed description of the above will now be given.

10 The colour integrating portion 11 of the colour separation means 30, when the chrominance signal output from the amplifying means 4 as illustrated in Figure 4 and the chrominance signal output from the 1H delay means 1 as illustrated in Figure 5 are input, integrates the same to thereafter output signals c and d.

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In other words, when a pulse ID alternatively output at a high and low level in every horizontal period goes high, the signal output from 1H delay means 1 is input to sample-and-hold portions 12 and 13, and the signal output from the amplifying means 4 to sample-and-hold portions 14 and 15.

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When the pulse ID goes low, the signal output from 1H delay means 1 is input to the sample-and-hold portions 14 and 15, and the signal output from the amplifying means 4 is input to the sample-and-hold portions 12 and 13.

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Accordingly, the signals such as $R+2B+G$, $2G+R$, $R+2B+G$, $2G+R$ as illustrated in Figure 5 and output from 1H delay means 1 at a common time t_1 are input to the sample-and-hold portions 12 and 13.

The signals such as $2G+B$, $2R+B+G$, $2G+B$, $2R+B+G$ as illustrated in Figure 4 and output from the amplifying means 4 are input to the sample-and-hold portions 14 and 15.

5 The signals such as $2G+B$, $2R+B+G$, $2G+B$, $2R+B+G$ as illustrated in Figure 5 and output from 1H delay means 1 at a common time t_2 are input to the sample-and-hold portions 14 and 15.

10 The signals like $R+2B+G$, $2G+R$, $R+2B+G$, $2G+R$ as illustrated in Figure 4 and output from the amplifying means 4 are input at time t_2 to the sample-and-hold portion 12 and 13.

15 As seen in the foregoing, the integrated signals in the colour integrating portion 11 are output as c and d, in response to the pulse ID in the orders of $R+2B+G$, $R+2G$, $R+2B+G$, $R+2G$ and $B+2G$, $2R+B+G$, $B+2G$, $2R+B+G$ on every horizontal line as per Figures 7 and 8 to thereby be input to the sample-and-hold portions 12 and 13, 14 and 15 respectively.

20 At the sample-and-hold portions 12 and 13, 14 and 15, the signals as illustrated in Figures 7 and 8 and outputs c and d from the colour integrating portion 11 are sampled and held by sampling pulses SP1 and SP2, resulting in only similar chrominance signals being output.

25 A more detailed explanation will now be given.

First, the chrominance signals such as $R+2B+G$, $R+2G$, $R+2B+G$, $R+2G$ as illustrated in Figure 7 and output c from the colour integrating portion 11 are respectively input to the sample-and-hold portions 12 and 13.

At this moment, when the chrominance signal $R+2B+G$ is input to the sample-and-hold portion 12, a sampling pulse SP1 as illustrated in Figure 9 is input to the sample-and-hold portion 12.

5 The sample-and-hold portion 12 samples the chrominance signal $R+2B+G$ input by the sampling pulse SP1 and holds it, thereby to output the same.

10 The following sampling pulse SP1 is also input to the sample-and-hold portion 12 when the chrominance signal $R+2B+G$ is input.

Therefore, the sample-and-hold portion 12 keeps outputting the chrominance signal $R+2B+G$.

15 When the chrominance signal $R+2G$ is input, the sampling pulse SP2 as illustrated in Figure 9 is input to another the sample-and-hold portion 13 to which the chrominance signals such as $R+2B+G$, $R+2G$, $R+2B+G$, $R+2G$ as illustrated in Figure 7 and output c from the colour integrating portion 11 are input.

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The sample-and-hold portion 13 samples the chrominance signal $R+2G$ input by the sampling pulse SP2 and holds it thereby to output the same.

25 The following sampling pulse SP2 is also input to the sample-and-hold portion 13 when the chrominance signal $R+2G$ is input.

Therefore, the sample-and-hold portion 13 keeps outputting the chrominance signal $R+2G$.

As depicted in the foregoing, the chrominance signals $B+2G$, $2R+B+G$, $B+2G$, $2R+B+G$ as illustrated in Figure 8 and output from the colour integrating portion 11 are input respectively to the sample-and-hold portions 14 and 15.

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At this moment, the sampling pulse SP1 as illustrated in Figure 9 is input to the sample-and-hold portion 14 when the chrominance signal $B+2G$ is input.

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The sample-and-hold portion 14 samples the chrominance signal $B+2G$ input by the sampling pulse SP1 and holds it thereby to output the same.

The following sampling pulse SP1 is also input to the sample-and-hold portion 14 when the chrominance signal $B+2G$ is input.

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Therefore, the sample-and-hold portion 14 keeps outputting the chrominance signal $B+2G$.

20 The sampling pulse SP2 as illustrated in Figure 9 is input to the sample-and-hold portion 15 to which the chrominance signal such as $B+2G$, $2R+B+G$, $B+2G$, $2R+B+G$ as illustrated in Figure 8 and output from the colour integrating portion 11 are input.

25 The sample-and-hold portion 15 samples the chrominance signal $2R+B+G$ input by the sampling pulse SP2 and holds it thereby to output the same.

The following sampling pulse SP2 is input to the sample-and-hold portion 15 when the chrominance signal $2R+B+G$ is input.

Therefore, the sample-and-hold portion 13 keeps outputting the chrominance signal $2R+B+G$.

Meanwhile, an adder 16 adds the chrominance signals $R+2B+G$ and $R+2G$ output from the sample-and-hold portions 12 and 13, thereafter to output the same.

An adder 17 adds the chrominance signals $B+2G$ and $2R+B+G$ output from the sample-and-hold portions 14 and 15, thereafter to output the result.

Furthermore, an adder 20 adds the chrominance signals output from the adders 16 and 17 thereafter to output Yl .

In other words, the adder 20 outputs a signal wherein the outputs of the sample-and-hold portions 12, 13, 14 and 15 are added, namely, $Yl = (R+2B+G) + (R+2G) + (B+2G) + (2R+B+G) = 3R + 4B + 5G$.

Here, as the luminance component is made by adding each pixel signal, the signal output from the adder 20 becomes the luminance signal.

A subtracter 18 subtracts the signal $R+2B+G$ output from the sample-and-hold portion 12 from the signal $R+2G$ output from the sample-and-hold portion 13 thereby to output a chrominance signal Cb .

A subtracter 19 subtracts the signal $B+2G$ output from the sample-and-hold portion 14 from the signal $2R+B+G$ output from the sample-and-hold portion 15 thereby to output a chrominance signal Cr .

5 In other words, the chrominance signal separation means 30 separates the chrominance signal of the B component, $Cb = (R+2G) - (R+2B+G) = -(2B - G)$, the chrominance signal of R component, $Cr = (2R+B+G) - (B+2G) = 2R - G$ and the luminance signal Yl , thereafter to output them.

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Figure 10 is a detailed constructional drawing of the horizontal contour correcting means 7 illustrated in Figure 1.

15 According to Figure 10, the horizontal contour correcting means 7 comprises: a pixel delayer 21 for delaying by 1 pixel a chrominance signal output from 1H delay means 1; a pixel delayer 22 for delaying again by 1 pixel the output of the pixel delayer 21; an adder 23 which adds the 2-pixel delayed chrominance signal output from the pixel delayer 22 and the chrominance signal output from the 1H delayer 1; an amplifier 24 for
20 decreasing by half the output from the adder 23; and a subtracter 25 for subtracting the output of the amplifier 24 from the chrominance signal delayed by 1 pixel and output from the pixel delayer 21.

25 The operation of the horizontal contour correcting means 7 illustrated in Figure 10 will be described in more detail with reference to the timing drawings in Figures 11A, 11B, 11C, 11D, 11E, and 11F.

First of all, when a chrominance signal as illustrated in Figure 11A is input to the horizontal contour correcting means 7, the pixel delayer 21 delays the chrominance signal by 1 pixel to thereafter output the same.

5 The chrominance signal output and delayed by 1 pixel by the pixel delayer 21 as illustrated in Figure 11B is delayed once more by 1 pixel at the pixel delayer 22.

10 The output of the pixel delayer 22 is as per the illustration in Figure 11C.

15 The adder 23 adds the chrominance signal output from the pixel delayer 22 as illustrated in Figure 11C and the chrominance signal output from the 1H delay means 1 as illustrated in Figure 11A thereafter to output the result.

 The output of the adder 23 is as per the illustration in Figure 11D.

20 The amplifier 24 decreases the output of the adder 23 by half to thereby output a signal as depicted in Figure 11E.

 The subtracter 25 subtracts the signal illustrated in Figure 11E and output from the amplifier 24 from a signal output from the pixel delayer 21 and illustrated in Figure 11B, thereby to output the result.

25 Therefore, the horizontal contour correcting signal output from the subtracter 25 is as per the illustration in Figure 11F.

The horizontal contour correcting signal output from the subtracter 25 is input to adder 8 illustrated in Figure 1

Meanwhile, the construction of the vertical contour correcting means 6 is just like that of the horizontal contour correcting means 7, the only difference being that each one-pixel delayer is replaced by a 1H delay means as illustrated in Figure 1.

As seen from the foregoing, the illustrated example of a circuit for colour separation and contour correction in accordance with the present invention utilizes 2 1H delay elements, thereby to perform colour separation and contour correction, resulting in a relatively simple circuit.

The foregoing description of the preferred embodiment has been presented for the purpose of illustration and description. It is not intended to limit the scope of this invention. In practice, many variations are possible to those skilled in the art without departing from the scope of the invention.



CLAIMS:

1. A circuit for colour separation and contour correction, comprising:

5 delay means for outputting 1H delayed and 2H delayed chrominance signals;

first adding means for adding the 2H-delayed chrominance signal from the delay means to a currently-input chrominance signal;

10 amplifying means for amplifying the output of the first adding means;

chrominance signal separation means for separating the chrominance signals of colour components from the output of the amplifying means and the 1H delayed chrominance signal from the delay means;

15 contour correcting means for generating vertical and horizontal contour correcting signals in response to the output of the 1H delayed chrominance signal from the delay means and the output of the amplifying means; and

20 second adding means for adding the vertical and horizontal contour correcting signals output from the contour correcting means to the 1H delayed chrominance signal thereby to output a luminance signal which has been corrected in contour,

25 wherein said chrominance signal separation means comprises:



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a colour integrating portion for integrating the chrominance signal output from the amplifying means and the 1H delayed chrominance signal from the delay means;

5 a sample-and-hold portion for sampling an identical chrominance signal portion from the chrominance signal output from the colour integrating portion thereby to keep outputting the same;

a subtracter for extracting red and blue components of chrominance signals in response to the signals output from the output of the sample-and-hold portion; and

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an adder for generating a luminance signal in response to the signals output from the output of the sample-and-hold portion.

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2. A circuit according to claim 1, wherein said contour correcting means comprises:

a vertical contour correcting portion for generating a vertical contour correcting signal from the 1H delayed chrominance signal from the delay means and the chrominance signal output from the amplifying means;

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a horizontal contour correcting means for generating a horizontal contour correcting signal from the 1H delayed chrominance signal from the delay means;

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an adder for adding the horizontal contour correcting signal output from the horizontal contour correcting portion and the vertical contour correcting signal output from the vertical contour correcting portion; and

5 an aperture compressor for compressing the vertical and horizontal contour correcting signals output from the adder.

3. A circuit according to either of the preceding claims, wherein said amplifying means has a gain of 0.5.

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4. A circuit according to any of the preceding claims, wherein said colour components are red and blue components.

5. A circuit for colour separation and contour correction, the circuit being
15 substantially as hereinbefore described with reference to Figure 1 of the accompanying drawings.

6. A circuit for colour separation and contour correction, the circuit being
20 substantially as hereinbefore described with reference to Figures 1 to 11 of the accompanying drawings.

7. A video camera provided with a circuit according to any of the preceding claims.