

Description

The present invention relates to apparatus for processing the luminance component of a video signal and more particularly for establishing a desired amplitude versus frequency response of the luminance component in, e.g., a digital television receiver. In order to improve the sharpness and fine detail resolution of the image, it is desirable to improve the transient response of the luminance channel by increasing the high frequency response of the luminance channel.

The response of video signal processing systems may be subjectively improved by increasing the steepness of amplitude transitions in the video signals, and the response may also be improved by the generation of a preshoot just before a transition and an overshoot just after the transition. It is also known that a desired amplitude or phase characteristic (or both) as a function of frequency may be formed substantially without introducing phase non-linearity or phase distortion by means of an apparatus wherein delayed signals generated at terminals (usually referred to as taps) along a delay line or like device are combined in a predetermined manner. Such apparatus, sometimes called a "transversal equalizer" or "transversal filter", is generally described in U.S. Pat. No. US-A-2,263,376 (A. D. Blumlein et al.).

In a television or similar system for processing a composite signal to provide a predetermined signal transfer characteristic, such as accentuation of selected frequencies, it is desirable to include peaking circuitry in the luminance channel which is readily adaptable to control (e.g., relatively accentuate or peak) high frequency portions of the luminance signal component of the video signal. For example, it may be desirable to controllably accentuate the amplitude of certain relatively high frequency portions of the luminance signals depending on the quality of the received television signal.

In this connection, the prior art includes circuitry, as described for instance in the Journal of the Society of Motion Picture and Television Engineers, Vol. 84, No. 7, July 1975 pp 545-551, which, by a combination of word stores and signal detail matrices, provides, in accordance with different algorithms, a signal with a controlled bandpass characteristic which is combined, with controlled gain, with a delayed main video signal having an unmodified broadband characteristic: the gain control adjustment varies the degree of detail enhancement (peaking).

Figure 1 illustrates a transfer function which when applied to the luminance signal produces very desirable subjectively improved reproduced images. The present invention is directed toward apparatus for generally emulating this transfer function in the luminance channel of a digital video signal processing system. In the context of a digital TV receiver such apparatus must be realized with a minimum of parts in order to produce a cost effective receiver.

It requires significant numbers of devices to perform even relatively simple digital processing functions. For example, to sum two 8-bit signals requires in excess of 200 transistors. It is readily apparent that in order to realize the requisite processing functions of a TV system in digital hardware, with a manageable and cost effective number of devices, each functional component must be designed in the simplest configuration commensurate with the desired response characteristics. Mindful of this constraint, the following peaking circuits were developed which, in the preferred embodiment, requires only one multiplier circuit.

Apparatus in accordance with one aspect of the present invention comprises a digital luminance processing circuit which, for permitting frequency dependent amplitude adjustment of the luminance signal comprises a finite impulse response (FIR) filter including a first cosine FIR filter in cascade connection with the parallel connection of second and third FIR filters. The second FIR filter produces a low pass filter response. The third FIR filter produces a response which attenuates the high frequency portion less than the low frequency portion. The third FIR filter includes a variable scaling device, the output port of which is connected to one input port of a combining means. The output port of the second FIR filter is coupled to a second input port of the combining means, the output port of which is the output port of the processing circuit.

In accordance with another aspect the filter functions can be provided in a processing circuit which is switchable between two transfer functions.

Apparatus according to this invention may be used as a peaking circuit for digital video processors. The high frequency response of the peaking circuit is adjusted by varying the scale factor applied to the variable scaling device. All of the filter weighting elements are realized by bit shifting the respective samples to minimize the required filter hardware.

In the drawings:

Figure 1 is a peaked amplitude versus frequency response curve for the luminance component of a video signal in a TV receiver which subjectively enhances reproduced images;

Figure 2 is a block diagram of a portion of a digital TV receiver including a digital peaking circuit;

Figures 3 and 6 are logic schematic diagrams of FIR filter circuits for generally emulating the transfer response curve of Figure 1, Figure 6 being a peaking circuit switchable between two transfer functions;

Figure 4 is a block diagram of a variable scaling circuit which may be employed in the circuit of Figures 3 and 6; and

Figure 5 is the relative amplitude versus frequency transfer function exhibited by the arrangement of Figure 3 for the factor K of the variable scaling circuit equal to, less than, and greater than 1.

Figure 7 is a schematic diagram of a simplified coring circuit.

In the Figures, thin lines represent signal paths for analog or single bit digital (e.g. clock) signals and thick lines represent signal paths for multibit digital signals (e.g. pulse code modulated binary signals.)

The luminance peaking circuit in a TV receiver is employed to subjectively enhance transitions of vertical lines in the displayed image. Signals representing relatively sharp transitions generally contain high frequency signal components. The transitions may be selectively enhanced by increasing the amplitude response of the high frequency components of the luminance signal relative to the low frequency components. However, care must be taken to ensure that the peaking of the higher frequencies of the luminance signal does not introduce ringing of these high frequency components. Thus, the overall peaking response must be tailored to roll off gradually at the upper end of the spectrum while guaranteeing a high degree of attenuation of frequencies in the range of the sound signal components. In addition, it is most desirable that the peaking response have linear phase characteristics. It has been found in the past that the general frequency response curve illustrated in Figure 1 produces the desired peaking characteristics when generated with linear phase components.

Figure 2 is a block diagram of part of a digital TV receiver indicating the major signal processing circuits including a luminance peaking circuit. In the figure, broadcast TV signals are received by antenna 10 and applied to conventional tuner and intermediate frequency (IF) circuitry 12. A baseband analog composite video signal from element 12 is applied to the input of an analog-to-digital converter (ADC) 14 which samples the signal at a rate of, e.g., four times the color subcarrier frequency and generates digital representations of the analog signal. The ADC 14 is controlled by a sampling signal provided by a clock generator 16 which may be a phase locked loop circuit responsive to the digitized color burst reference component of the composite signal. Output samples from ADC 14 are applied to a comb filter 18 which selectively extracts the luminance and chrominance components of the composite video signal. The chrominance component is applied to the chrominance processing circuit 20, which may include gain control function, filter circuits and color mixture signal demodulating circuitry, wherein the chrominance signal is suitably conditioned for application to the color matrix circuit 26.

The luminance component from comb filter 18 is applied to the luminance processing circuit 22 which may include brightness control and vertical detail enhancement functions, etc. The conditioned luminance signal from processor 22 is applied to the luminance peaking circuit 24 which selectively enhances the amplitude response of the higher frequency components of the lumi-

nance signal. The peaked luminance signal from element 24 is applied to the color matrix 26 wherein it is appropriately combined with the processed chrominance signal to generate R, G and B color signals for driving the display tube.

Figure 3 is a peaking circuit comprised of delay stages, adders, and one multiplier element 47. Multiplier element 47 is of the type which scales applied signals by a constant factor. Multiplier 47 is desirably of the type wherein its scale factor K is electrically variable by control signals applied to its control input terminal 50 so that the peaking function may be adapted to the condition of the applied luminance signal. Ideally, the scale factor K should be linearly variable to provide a wide range of adaptability.

In Figure 3 luminance samples are applied to input port 30 and peaked samples are available at the output port 49 of adder 48. The luminance samples are coupled to the input port of delay element 31 which is serially coupled to adder circuit 51. The luminance samples are also applied to a second input port of adder 51. Delay element 31 and adder circuit 51 form a first FIR filter. The transfer function exhibited at the output of adder 51 relative to the input samples applied to port 30 is a cosine response. In "z" transform notation the transfer function is described by the equation

$$S51/SIN = 1 + z^{-1} \quad (1)$$

where S51 and SIN are the values of the signal samples at the output port of adder 51 and input port 30 respectively.

Output samples from adder 51 are applied to a second filter including circuit elements 32, 33, 34, 35, 38, 41 and 42 and to a third filter including circuit elements 33, 35, 36, 37, 39, 40, 43, 44, 45, 46 and 47. Circuit elements 33, 35, 42, 43 and 45 are delay elements which delay signal samples by one sample period and are for example latches clocked synchronously at the sample rate. Circuit elements 34, 36 and 39 are times-two multipliers. Assuming that the samples are n-bit pulse code modulated (PCM) binary codes, the times-two multipliers may be wiring arrangements which alter or shift the significance of the bit positions, of the respective samples, leftward one bit position (where the leftmost bit of the PCM code is the most significant bit). Circuit elements 32, 37, 38 and 40 are binary adders and elements 44 and 46 are binary subtractors designed to comport with the signal format, e.g. two's complement numbers. Circuit element 41 is a scaling circuit which divides samples by a factor of four. For binary PCM samples, element 41 may be a wiring arrangement which alters the significance of the sample bits two bit positions rightward.

The second filter, in the frequency range of interest, provides a generally low pass response with a fixed gain coefficient. The third filter, in the frequency range of interest, provides a generally high frequency or band pass response with a variable gain coefficient, i.e., the third filter

attenuates lower frequency components of luminance signal more than the relatively higher frequency components. Output signal from the second and third filters are linearly summed to produce the peaked luminance signal wherein the second filter contributes the lower frequency luminance components and the third filter contributes the higher frequency components. Since the third filter has a variable gain coefficient the amplitude of the higher frequency components of the luminance signal can be scaled relative to the low frequency component to produce the most desirable composite response.

In Figure 3 the second filter is the upper signal path and the third filter the lower signal path of the illustrated circuitry. Considering first the upper signal path, samples from adder 51 are applied to one input port of adder circuit 32 and to the input port of delay element 33. Output samples from delay element 33 are applied to the input port of delay element 35 and to times-two circuit 34. Weighted samples from times-two circuit 34 are applied to a second input port of adder 32, the output of which is coupled to a first input port of adder 38. Output samples from delay element 35 are applied to a second input port of adder 38. Output samples from adder 38 are divided by four in element 41. Samples from element 41 are applied to delay element 42 which delays the combined and weighted samples by one sample period. In "z" transform notation the transfer function provided by the elements between adder 51 and the output port of delay element 42 is described by the equation

$$S_{42}/S_{51} = \frac{1}{4}(1 + 2z^{-1} + z^{-2})z^{-1} \quad (2)$$

which corresponds to the transfer function of the second filter and is in general a low pass response. The complete transfer function between input port 30 and the output port of delay element 42 is described by

$$S_{42}/S_{IN} = \frac{1}{4}(z^{-1} + 3z^{-2} + 3z^{-3} + z^{-4}). \quad (3)$$

Samples from the output port of adder 51 are applied to times-two multiplier 36, the output port of which is coupled to a first input port of adder 37. Samples from delay element 33 are coupled to a second input port of adder 37, the output of which is coupled to a first input port of adder 40. Samples from delay element 35 are multiplied by two in element 39 and thereafter applied to a second input port of adder 40. The transfer function provided by the elements between adder 51 and the output port of adder 40 is given by

$$S_{40}/S_{51} = 2 + z^{-1} + 2z^{-2} \quad (4)$$

which is in general a low pass response.

Samples from adder 40 are applied to delay element 43 and as minuends to subtraction circuit 44. Output samples from delay element 43 are applied as subtrahends to subtraction circuit 44. The transfer function provided by the elements

between adder 40 and the output port of subtraction circuit 44 is given by

$$S_{44}/S_{50} = 1 - z^{-1}. \quad (5)$$

Samples from subtraction circuit 44 are applied to the input port of delay element 45 and as subtrahends to subtraction element 46. Delayed output samples from delay element 45 are applied as minuends to subtraction circuit 46. The transfer function provided by the circuit elements between the output of subtraction circuit 44 and the output port of subtraction circuit 46 is given by

$$S_{46}/S_{44} = z^{-1} - 1. \quad (6)$$

Output samples from subtraction circuit 46 are applied to the input port of variable gain multiplier 47 which multiplies the samples by the variable factor K. The composite transfer function between the input port 30 and the output port of multiplier 47 is given by

$$S_{47}/S_{IN} = -2K + Kz^{-1} + Kz^{-2} + Kz^{-3} + Kz^{-4} - 2Kz^{-5} \quad (7)$$

which in general is a bandpass response.

Samples from delay element 42 and variable gain multiplier 47 are combined in adder 48 which provides output samples from the peaking circuit at output port 49. The transfer function T(z) of the peaking circuit is given by the equation

$$T(z) = -2K + (K + \frac{1}{4})z^{-1} + (K + \frac{3}{4})z^{-2} + (K + \frac{3}{4})z^{-3} + (K + \frac{1}{4})z^{-4} - 2Kz^{-5}.$$

The transfer function of the peaking circuit is generally illustrated in Figure 5. Note the response is generally flat near DC then rises and peaks between 2.2—2.5 MHz and then rolls off crossing through zero near 4.05 MHz. The response curve has a minimum value of about -40 dB at approximately 4.2 MHz. The response curve then rises again and peaks near 5.7 MHz. This latter peak is undesirable. However, it is assumed that prefiltering before analog-to-digital conversions will substantially eliminate all signal components in this part of the frequency spectrum.

In Figure 5 the solid curve represents the response curve for a K factor of 1. The dotted and broken line curves represent the response curves for K factors greater and less than one respectively. For a K factor of zero the high frequency luminance components will be significantly attenuated relative to the DC response. By appropriate selection of the factor K the luminance signal may be either peaked or depeaked. (Note—the response curve illustrated in Figure 5 assumes a sample rate occurring at four times the frequency of the color subcarrier of an NTSC composite color video signal.)

Figure 4 is a logic schematic diagram of a variable multiplier circuit which may be implemented for the element 47 in Figure 3. This

circuit is a programmable shift-and-and type weighting circuit capable of weighting samples by factors which are the sums of powers of two and/or reciprocal powers of two. The illustrated circuit includes only four bit-shifters and three adders to produce a sixteen step linear response for a four bit control signal. The illustrated circuit multiplies by a factor K equal to one-eighth the value of the decimal number corresponding to the four bit binary control signal $C_1C_2C_3C_4$. For example, if $C_1C_2C_3C_4$ are 0101 respectively which equals decimal 5, then the K factor is 5/8.

Signals to be multiplied are applied to input port 80. The samples are applied to bit shifters 60-63 which shift the bits of the applied PCM samples by 0, 1, 2 and 3 significant bit positions rightward respectively corresponding to a scaling by 1, 1/2, 1/4 and 1/8. The sign bit line is connected for two's complement numbers which requires that the more significant bit positions that are vacated in the bit shifted PCM signals replicate the sign bit. The bit-shifted or scaled samples are applied to gating circuits 64-67 controlled by control lines C_1 , C_2 , C_3 and C_4 respectively. Responsive to a logic zero on the control line the corresponding gating circuit outputs a zero valued sample. Responsive to a logic one on the control line, the corresponding gating circuit passes the applied scaled sample. The scaled output samples or zero values from the gating circuits 64-67 are summed in the adder tree including adder circuits 68, 69 and 70 to produce the input samples weighted by the scale factor K, at the output port 71.

Returning to the example of $C_1C_2C_3C_4$ equal to 0101 and an input sample of decimal value 16, the decimal values applied by bit-shifters 60-63 to gating circuits 64-67 are 16, 8, 4 and 2 respectively. Gating circuits 64 and 66 responsive to logic zero "0" control signals produce zero valued output values and gating circuits 65 and 67 responsive to logic one control signals produce output values 8 and 2 respectively which sum to the decimal value 10. The binary value of the control signals 0101 equals decimal 5 and the K factor is thus 5/8. Five-eighths of sixteen equals 10 which is the output value produced by the adder tree at output terminal 71.

The circuit of Figure 4 can be expanded to produce a larger number of multiplication factors by including additional bit-shifters in parallel with bit shifters 60-63 and corresponding, gating circuits and adders, or by making the bit shifters programmable rather than hardwired.

Depending on the technology employed to realize the circuitry, it may be necessary to use pipelining techniques to accommodate differences in circuit delays, for example, where two adder circuits are connected in cascade as in Figures 3 and 4. Those skilled in the art will recognize such conditions and design their circuitry accordingly.

Figure 6 is a peaking circuit switchable between two transfer functions. One of the transfer functions is similar to the transfer function of the

Figure 3 apparatus. The second transfer function is generally a wideband response with a null at 7.2 MHz (for NTSC sample rates). Additionally, the Figure 6 circuitry includes adaptive coring circuitry. Elements in Figure 6 designated with like numerals as elements in Figure 3 perform like functions.

Elements 82 and 81 make up the adaptive coring circuitry which for large signals may be assumed to provide a unity transfer function, i.e. they do not affect the signal. Assuming this to be the case, the transfer function between input port 30 and output port 49 is identical to that of the Figure 3 circuit when the contacts of switch 83 are connected to terminals AA'. The circuitry to the left of switch 83 is slightly more parts efficient than the corresponding circuitry of Figure 3, but it can be shown that it performs the same function.

Next consider both contacts of switch 83 connected to terminal B. In this state it can readily be shown that the transfer function, F_B , between input port 30 and output port 49 is described by the equation

$$F_B = -Kz^{-1} + (K+1)z^{-2} + (K+1)z^{-3} - Kz^{-4} \quad (9)$$

which in general is a cosine like frequency response having a null at approximately 7.2 MHz. The circuit is operated in this mode when it is desired to reproduce the maximum possible horizontal detail as for displaying text material, for example. The switch 83 may be a manually operated switch or an electronic switch means, e.g. responsive to the current signal spectral content. The function F_B is also a peaked function.

The peaking function is accomplished by enhancing the higher frequency components of the signal spectrum and adding the enhanced components back with the lower frequency components. In video signals, however, the higher frequency components are typically significantly attenuated relative to lower frequency components. This attenuation is a consequence of video signals being broadcast with insufficient bandwidth. The result is that the higher frequency components have a poorer signal-to-noise ratio and are particularly susceptible to quantization noise from the analog-to-digital conversion process. When the received signal is weak, the signal-to-noise ratio of the higher frequency components tends to degrade significantly and the peaking circuit ends up adding enhanced noise back into the signal. This undesirable result may be prevented by coring the enhanced signal prior to adding it back to the other frequency components.

Coring is a signal processing operation in which low-level signal variations are removed from a signal to improve the overall signal-to-noise ratio. Fixed threshold coring, in which low-level signal variations not exceeding a fixed threshold level are removed, is generally inadequate in a TV receiver because the viewer is more perceptive of noise occurring in a dark scene (i.e. light spots in a dark background) than a light scene (i.e. dark

spots in light background). It is therefore desirable to provide a relatively higher coring threshold for low luminance signal levels or darker scenes and a relatively lower coring threshold for lighter scenes.

Referring again to Figure 6, element 82 is a coring circuit, an example of which is shown in Figure 7. Element 81 is a memory element programmed to output particular threshold values to coring circuit 82. Luminance signal from multiplier 47 is applied to the signal input port of coring element 83 wherein it is compared with the threshold value from memory element 81. If the signal value is larger than the threshold value, the signal is passed to adder 48. If the signal value is less than the threshold value, a predetermined value, e.g. zero is output by corer 83 to adder 48.

The signal addressing the threshold value memory 81 is low frequency luminance which, in general, represents the average image brightness. Low frequency luminance is obtained via delay element 78 and adder 79 coupled to the output port of adder circuit 77. The filter transfer function, S_{79}/S_{30} , provided by the elements coupled between signal input port 30 and the output port of adder 79 is given by the equation

$$S_{79}/S_{30} = (1+z^{-1})(1+z^{-2})^2. \quad (10)$$

This filter function is a low pass response and has a 3 dB point at approximately 1.2 MHz, and is acquired with minimal additional hardware keeping within the design goals.

The signal samples from adder 79 are divided by a factor of 64, e.g. right shifted six significant bit positions before applying them to the address input port of memory element 81. The signal is divided for two reasons. First, it is unnecessary that the threshold values have high resolution, i.e. thirty-two different threshold values are sufficient for seven bit plus sign bit luminance signals. Secondly, if the input samples at port 30 are eight bits wide, after coursing through adder circuits 51, 77 and 79 they are increased to a width of 11 bits. The lower order bits are insignificant with respect to the nominal coring thresholds and thus contain no useful control information. The division may be performed ahead of delay element 78 and adder 79 to further reduce the hardware requirements. As a further alternative, the division may be split with a portion ahead of delay element 78 and a portion after adder 79. For example, a four bit right shift may be done ahead of elements 78 and 79 followed by a two bit right shift after element 79. This reduces the size of adder 79 from a 10 bit device to a six bit device, an appreciable hardware saving. This last example provides a good compromise between hardware savings and round off errors which result from division by bit shifts (and truncation).

Figure 7 shows one coring circuit which may be implemented as element 82 in Figure 6. This circuit consists of a digital comparator 130 to which input signals from multiplier 47 and threshold values from memory 81 are applied. If

the magnitudes of samples from multiplier 47 exceed the threshold value, comparator 130 outputs a logically high gating signal, GS, otherwise comparator 130 develops a logical low level at output GS. Gating signal GS is applied to respective first input terminals of the parallel array of AND gates 122—128. Respective bits of the signal samples from multiplier 47 are applied to respective second input terminals of AND gates 122—128. When the gating signal GS is high the AND gates 122—128 pass the input signals to the output port 200 of the coring circuit unaltered. Alternatively, when the gating signal GS is low, AND gates 122—128 provide logical low values to output port 200. Note that comparator 130 may be a window comparator arranged to provide a logical high output signal whenever the input signal is greater than the applied threshold value or lesser than the negative of the threshold value, and to produce a logical low output level otherwise.

Claims

1. A processing circuit for frequency dependent amplitude adjustment of digital video luminance signals characterized by the combination of:

a first FIR filter (31, 51) having an input port for receiving digital video luminance signals and having an output port, said first FIR filter exhibiting a cosine transfer function;

a second FIR filter (32, 33, 34, 35, 38, 41, 42) having an input port coupled to the output port of said first FIR filter and having an output port, said second FIR filter exhibiting a generally low pass frequency response;

a third FIR filter (33, 35, 36, 37, 39, 40, 43, to 47) having an input port coupled to the output port of said first FIR filter and having an output port, and including a variable scaling circuit (47) responsive to gain control signals (50), said third FIR filter exhibiting a frequency response which attenuates the relative high frequency spectrum of luminance signal less than the relatively low frequency spectrum of luminance signal; and

combining means (48) coupled to the output ports of said second and third FIR filters for combining filtered signal samples provided thereby, said combined filtered samples (49) corresponding to processed digital video luminance signal.

2. A circuit according to claim 1, characterized by:

said first FIR filter (31, 51) exhibiting the transfer function $f1=1+z^{-1}$ where z connotes the conventional z transform;

said second FIR filter (32, 33, 34, 35, 38, 41, 42) exhibiting the transfer function

$$f2=\frac{1}{2}(z^{-1}+2z^{-2}+z^{-3});$$

and

said third FIR filter (33, 35, 36, 37, 39, 40, 43, to 47) exhibiting the transfer function



spots in light background). It is therefore desirable to provide a relatively higher coring threshold for low luminance signal levels or darker scenes and a relatively lower coring threshold for lighter scenes.

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a second FIR filter (32, 33, 34, 35, 38, 41, 42) having an input port coupled to the output port of said first FIR filter and having an output port, said second FIR filter exhibiting a generally low pass frequency response;

a third FIR filter (33, 35, 36, 37, 39, 40, 43, to 47) having an input port coupled to the output port of said first FIR filter and having an output port, and including a variable scaling circuit (47) responsive to gain control signals (50), said third FIR filter exhibiting a frequency response which attenuates the relative high frequency spectrum of luminance signal less than the relatively low frequency spectrum of luminance signal; and

combining means (48) coupled to the output ports of said second and third FIR filters for combining filtered signal samples provided thereby, said combined filtered samples (49) corresponding to processed digital video luminance signal.

2. A circuit according to claim 1, characterized by:

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said second FIR filter (32, 33, 34, 35, 38, 41, 42) exhibiting the transfer function

$$f2 = \frac{1}{4}(z^{-1} + 2z^{-2} + z^{-3});$$

and

said third FIR filter (33, 35, 36, 37, 39, 40, 43, to 47) exhibiting the transfer function



$$K(-2+3z^{-1}-2z^{-2}+3z^{-3}-2z^{-4})$$

where K is a constant.

3. A circuit according to claim 2 characterized in that said first FIR filter (31, 51) comprises a delay element (31) having an input port and an output port and an adder circuit (51) having first and second input ports coupled respectively to the input and output ports of said delay element, said adder circuit having an output port corresponding to the output port of said first FIR filter.

4. A circuit according to claim 2 or 3 characterized in that the second FIR filter (32, 33, 34, 35, 38, 41, 42) comprises:

first (33) and second (35) cascaded connected delay elements having respective output ports, the first delay element having an input port coupled to the output port of the first FIR filter

first weighting means (34) coupled to the output port of the first delay element for weighting signal samples from said first delay element;

means (32, 38) coupled to the input port of the first delay element, the output port of the second delay element and said first weighting means for combining signal samples available therefrom;

second weighting means (41) coupled to the means for combining signal samples for weighting the combined signal samples; and

a third delay element (42) having an input port coupled to second weighting means and having an output port which corresponds to the output port of said second FIR filter.

5. A circuit according to claim 2, 3 or 4 characterized in that the third FIR filter (33, 35, 36, 37, 39, 40, 43 to 47) comprises:

first (33) and second (35) cascade connected delay elements having respective output ports, said first delay element having an input port coupled to the output port of said first FIR filter;

first (36) and second (39) weighting circuits respectively coupled to the input port of the first delay element and the output port of the second delay element for weighting signal samples respectively applied thereto;

means (37, 40) coupled to the first and second weighting circuits and the output port of the first delay element for combining signal samples from said weighting circuits and said first delay element;

first (44) and second (46) subtraction circuits;

a third delay element (43) having an output port and having an input port coupled to said means for combining signal samples;

respective means for coupling the input and output ports of said third delay element to minuend and subtrahend input ports respectively of said first subtraction circuit;

a fourth delay element (45) having an input port coupled to said first subtraction circuit and having an output port;

respective means for coupling the input and output ports of said fourth delay element to subtrahend and minuend input ports respectively of said second subtraction circuit; and

said variable scaling circuit comprises a multi-

plier circuit (47) having an input port (50) coupled to the second subtraction circuit and having an output port corresponding to the output port of said third filter.

6. A circuit according to claim 5 characterized in that the multiplier circuit (47) comprises:

a plurality of gated weighting circuits (60, 64; 61, 65; 62, 66; 63, 67) having respective data input ports coupled to the input port (80) of said multiplier and having respective control input terminals (C1—C4), each of said gated weighting circuits providing at respective output ports, weighted replicas of signal samples applied to said input ports for a first logic state applied to its respective control terminal or zero valued samples for a second logic state applied to its respective control terminal, and each of said gated weighting circuits being arranged to weight input samples by successively decreasing values; and

means (68, 69, 70) for combining output samples from all of said gated weighting circuits to produce scaled replicas of samples applied to said multiplier circuit.

7. A circuit according to claim 6 characterized in that each of said plurality of gated weighting circuits comprises:

an n+1-input AND gate (64—67), n of said inputs being signal sample inputs and the n+1st input being coupled to its respective control terminal (C1—C4); and

bit-shift means (60—63) for altering the significance of sample bit positions, said bit-shift means being coupled between the n signal sample inputs of the AND gate and the multiplier input port (80).

8. A circuit according to any preceding claim characterized in that said combining means (48) is coupled to said third FIR filter (33, 35, 36, 37, 39, 40, 43, 44, 45, 46, 47) by apparatus comprising:

a coring circuit (82) having a threshold value input port, said coring circuit having a signal path connected between said third FIR filter and said combining means;

digital control means (81), having an input port coupled to the output port of said third FIR filter, for developing digital threshold values and applying them to the threshold value input port of said coring circuit; and

a fourth FIR filter (78, 79, 80) having an input port coupled to the output port of said first FIR filter (31, 51) and an output port coupled to said digital control means, said fourth FIR filter exhibiting a low pass frequency response.

9. A circuit according to claim 8 characterized in that the transfer functions f_4 of the fourth FIR filter is given by the equation

$$f_4 = W(1+z^{-2})^2$$

where W is a scale factor.

10. A circuit according to claim 8 or 9 characterized in that:

said digital control means (81) comprises memory means having a data output port



coupled to said threshold value input port, and having an address input port, said memory means being programmed to provide threshold values corresponding to applied address signals; and in that

the output port of said fourth FIR filter is coupled to said address input port.

11. A circuit according to claim 8, 9 or 10 characterized in that

said coring circuit (82) has an input port coupled to said third FIR filter (33, 35, 36, 37, 39, 40, 43, to 47) and an output port coupled to said means (48) for combining signal samples, said coring circuit including comparing means (130) for comparing signal samples from said third FIR filter and said threshold signals, said coring circuit (122—128) producing said signal samples as output samples in response to a first result of comparison and producing a predetermined digital signal as output signal in response to a second result of comparison.

12. A processing circuit for frequency dependent amplitude adjustment of digital video luminance signals, comprising:

an input port (30) for applying said luminance signal; characterized by the combination of:

switch means (83) having first (A), second (A') and third (B) input ports and first and second output ports for selectively connecting its first and second output ports to its first and second input ports respectively or alternatively connecting its first and second output ports simultaneously to its third input port;

means (31, 51, 75, 76, 77, 86, 87, 41) coupled between said input port and said switch means first input port and exhibiting the transfer function

$$W(1+3z^{-1}+3z^{-2}+z^{-3})$$

where W is a scale factor;

means (31, 51, 75, 76, 84, 85) coupled between said input port and the second input port of said switch means and exhibiting the transfer function

$$2+3z^{-1}+3z^{-2}+2z^{-3};$$

means (31, 51, 75) coupled between said input port and the third input port of said switch means exhibiting the transfer function

$$z^{-1}(1+z^{-1});$$

signal combining means (48) having first and second input ports and having an output port at which processed luminance signal is available;

means (42) exhibiting the transfer function z^{-1} for coupling the first output port of said switch means to the first input port of said signal combining means;

means (43, 44, 45, 46, 47, 82) for coupling the second output port of said switch means to the second input port of said signal combining means, including circuitry exhibiting the transfer function

$$K(-1+2z^{-1}-z^{-2})$$

where K is a scaling factor.

13. A processing circuit as set forth in claim 12 characterized in that the means for coupling the switch means to the second input port of said signal combining means further includes an adaptive coring circuit (81, 82) responsive to coring control circuitry (31, 51, 75, to 80) coupled to said input port and exhibiting the transfer function

$$D(1+z^{-1})(1+z^{-2})^2$$

where D is a scaling factor.

Patentansprüche

1. Verarbeitungsschaltung für eine frequenzabhängige Amplitudeneinstellung von digitalen Luminanz-Videosignalen gekennzeichnet durch die Kombination aus:

einem ersten FIR-Filter (31, 51), welches einen Eingang zum Empfang digitaler Luminanzvideosignale und einen Ausgang hat und eine Cosinus-Übertragungsfunktion aufweist;

einem zweiten FIR-Filter (32, 33, 34, 35, 38, 41, 42), das einen mit dem Ausgang des ersten FIR-Filters gekoppelten Eingang sowie einen Ausgang hat und im wesentlichen einen Tiefpaß-Frequenzgang aufweist;

einem dritten FIR-Filter (33, 35, 36, 37, 39, 40, 43 bis 47), welches einen mit dem Ausgang des ersten FIR-Filters gekoppelten Eingang sowie einen Ausgang hat und eine veränderliche Wichtungsschaltung (47), die Verstärkungsregelsignale (50) anspricht, enthält und einen Frequenzgang aufweist, der das relativ hochfrequente Spektrum des Luminanzsignals weniger dämpft als das relativ niederfrequente Spektrum des Luminanzsignals; und

einer Kombiniereinrichtung (48), die mit den Ausgängen des zweiten und des dritten FIR-Filters gekoppelt ist, um die von diesen gelieferten gefilterten Signalwerte zu kombinieren, wobei die kombinierten gefilterten Signalwerte (49) dem verarbeiteten digitalen Luminanzvideosignal entsprechen.

(Anmerkung des Übersetzers: FIR-Filter=Filter mit begrenzter Impulsansprache)

2. Schaltungsanordnung nach Anspruch 1, dadurch gekennzeichnet, daß

das erste FIR-Filter (31, 51) die Übertragungsfunktion

$$f_1=1+z^{-1}$$

hat, wobei z die konventionelle z-Transformation bedeutet;

das zweite FIR-Filter (32, 33, 34, 35, 38, 41, 42) die Übertragungsfunktion

$$f_2=1/4(z^{-1}+2z^{-2}+z^{-3})$$

aufweist; und



das dritte FIR-Filter (33, 35, 36, 37, 39, 40, 43 bis 47) die Übertragungsfunktion

$$f_3 = K(-2 + 3z^{-1} - 2z^{-2} + 3z^{-3} - 2z^{-4})$$

aufweist, wobei K eine Konstante ist.

3. Schaltungsanordnung nach Anspruch 2, dadurch gekennzeichnet, daß das erste FIR-Filter (31, 51) ein Verzögerungselement (31), das einen mit einer Quelle (30) gekoppelten Eingang sowie einen Ausgang hat, und eine Addierschaltung (51), die einen ersten und einen zweiten Eingang, die mit dem Eingang bzw. Ausgang des Verzögerungselements gekoppelt sind, enthält, wobei die Addierschaltung einen Ausgang entsprechend dem Ausgang des ersten FIR-Filters hat.

4. Schaltungsanordnung nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß das zweite FIR-Filter (32, 33, 34, 35, 38, 41, 42) enthält:

ein erstes (33) und ein zweites (35) Verzögerungselement, die in Kaskade geschaltet sind und jeweils einen Ausgang aufweisen, wobei das erste Verzögerungselement einen mit dem Ausgang des ersten FIR-Filters gekoppelten Eingang hat.

eine erste Wichtungseinrichtung (34), die mit dem Ausgang des ersten Verzögerungselements gekoppelt ist, um Signalwerte vom ersten Verzögerungselement zu wichten;

eine Einrichtung (32, 38), die mit dem Eingang des ersten Verzögerungselements, dem Ausgang des zweiten Verzögerungselements und der ersten Wichtungseinrichtung gekoppelt ist, um die von diesen verfügbaren Signalwerte zu kombinieren;

eine zweite Wichtungseinrichtung (41), die mit der Einrichtung zum Kombinieren der Signalwerte gekoppelt ist, um die kombinierten Signalwerte zu wichten; und

ein drittes Verzögerungselement (42), das einen mit der zweiten Wichtungseinrichtung gekoppelten Eingang und einen Ausgang hat, der dem Ausgang des zweiten FIR-Filters entspricht.

5. Schaltungsanordnung nach Anspruch 2, 3 oder 4, dadurch gekennzeichnet, daß das dritte FIR-Filter (33, 35, 36, 37, 39, 40, 43 bis 47) enthält:

ein erstes (33) und ein zweites (35) Verzögerungselement, die in Kaskade geschaltet sind und jeweils einen Ausgang aufweisen, wobei das erste Verzögerungselement einen mit dem Ausgang des ersten FIR-Filters gekoppelten Eingang aufweist;

eine erste (36) und eine zweite (39) Wichtungsschaltung, die mit dem Eingang des ersten Verzögerungselements bzw. dem Ausgang des zweiten Verzögerungselements gekoppelt sind, um die an sie angelegten Signalwerte zu wichten;

eine Einrichtung (37, 40), die mit der ersten und der zweiten Wichtungsschaltung sowie dem Ausgang des ersten Verzögerungselements gekoppelt ist, um die Signalwerte von den Wichtungsschaltungen und dem ersten Verzögerungselement zu kombinieren;

eine erste (44) und eine zweite (46) Subtrahierschaltung;

ein drittes Verzögerungselement (43), das einen Ausgang und einen mit der Einrichtung zum Kombinieren der Signalwerte gekoppelten Eingang hat;

Einrichtungen zum Koppeln des Eingangs und des Ausgangs des dritten Verzögerungselements mit einem Minuenden- bzw. einem Subtrahenden-Eingang der ersten Subtrahierschaltung;

ein viertes Verzögerungselement (45), das einen mit der ersten Subtrahierschaltung gekoppelten Eingang sowie einen Ausgang hat;

Einrichtungen zum Koppeln des Eingangs und des Ausgangs des vierten Verzögerungselements mit einem Subtrahenden- bzw. Minuenden-Eingang der zweiten Subtrahierschaltung; und

daß die veränderliche Wichtungsschaltung eine Multiplizierschaltung (47) enthält, die einen mit der zweiten Subtrahierschaltung gekoppelten Eingang (50) und einen Ausgang, der dem Ausgang einer dritten digitalen Verarbeitungsschaltung entspricht, hat.

6. Schaltungsanordnung nach Anspruch 5, dadurch gekennzeichnet, daß die Multiplizierschaltung (47) enthält:

eine Mehrzahl von getasteten Wichtungsschaltungen (60, 64; 61, 65; 62, 66; 63, 67), die jeweils einen mit dem Eingang (80) des Multiplizierers gekoppelten Dateneingang und jeweils einen Steuereingangsanschluß (C1—C4) haben und an ihren Ausgängen jeweils gewichtete Abbilder der den Eingängen zugeführten Signalwerte liefern, wenn an den jeweiligen Steueranschluß ein erster Logikzustand angelegt ist oder Signalwerte Null, wenn an dem jeweiligen Steueranschluß ein zweiter Logikzustand angelegt ist, wobei die getasteten Wichtungsschaltungen jeweils so ausgebildet sind, daß sie die Eingangssignalwerte mit sukzessive kleineren Werten wichten; und

eine Einrichtung (68, 69, 70) zum Kombinieren der Ausgangssignalwerte von allen getasteten Wichtungsschaltungen zur Erzeugung von gewichteten Abbildern der der Multiplizierschaltung zugeführten Signalwerte.

7. Schaltungsanordnung nach Anspruch 6, dadurch gekennzeichnet, daß die getasteten Wichtungsschaltungen jeweils enthalten:

ein UND-Glied (64 bis 67) mit $n+1$ Eingängen, von denen n Eingänge Signalwerteingänge sind und der Eingang $n+1$ mit dem jeweiligen Steueranschluß (C1 bis C4) gekoppelt ist und

eine zwischen die n Signalwerteingänge des UND-Gliedes und den Multiplizierer-Eingang (80) gekoppelte Bit-Verschiebungseinrichtung (60 bis 63) zur Änderung des Stellenwertes der Bit-Stellen der Signalwerte.

8. Schaltungsanordnung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Kombiniereinrichtung (48) mit dem dritten FIR-Filter (33, 35, 36, 37, 39, 40, 43, 44, 45, 46, 47) durch eine Anordnung gekoppelt ist, welche enthält:

eine Entfernungserschaltung (82), die einen Schwellenwert-Eingang sowie einen zwischen das dritte FIR-Filter und die Kombiniereinrichtung geschalteten Signalweg aufweist;



eine digitale Steuereinrichtung (81), die einen mit dem Ausgang des dritten FIR-Filters gekoppelten Eingang hat, um digitale Schwellenwerte zu erzeugen und dem Schwellenwerteingang der Entkernungsschaltung zuzuführen; und

ein viertes FIR-Filter (78, 79, 80), das einen mit dem Ausgang des ersten FIR-Filters (31, 51) gekoppelten Eingang und einen mit der digitalen Steuereinrichtung gekoppelten Ausgang hat, und einen Tiefpaß-Frequenzgang aufweist.

9. Schaltungsanordnung nach Anspruch 8, dadurch gekennzeichnet, daß die Übertragungsfunktion f_4 des vierten FIR-Filters durch die Gleichung

$$f_4 = W(1+z^{-2})^2$$

gegeben ist, wobei W ein Wichtungsfaktor ist.

10. Schaltungsanordnung nach Anspruch 8 oder 9, dadurch gekennzeichnet, daß

die digitale Steuereinrichtung (81) eine Speichereinrichtung enthält, die einen mit dem Schwellenwerteingang gekoppelten Datenausgang sowie einen Adresseneingang hat und für die Lieferung von Schwellenwerten entsprechend zugeführten Adressensignalen programmiert ist und daß

der Ausgang des vierten FIR-Filters mit dem Adressen-Eingang gekoppelt ist.

11. Schaltungsanordnung nach Anspruch 8, 9 oder 10, dadurch gekennzeichnet, daß die Entkernungsschaltung (82) einen mit dem dritten FIR-Filter (33, 35, 36, 37, 39, 40, 43 bis 47) gekoppelten Eingang und einen mit der Einrichtung (48) zum Kombinieren der Signalwerte gekoppelten Ausgang aufweist, eine Vergleichereinrichtung (130) zum Vergleichen der Signalwerte vom dritten FIR-Filter und der Schwellenwertsignale enthält und daß die Entkernungsschaltung (122 bis 128) die Signalwerte als Ausgangswerte in Ansprache auf ein erstes Ergebnis des Vergleichs und ein vorgegebenes digitales Signal als Ausgangssignal in Ansprache auf ein zweites Ergebnis des Vergleichs liefert.

12. Verarbeitungsschaltung zur frequenzabhängigen Amplitudeneinstellung von digitalen Luminanz-Videosignalen, mit

einem Eingangsanschluß (30) zum Zuführen des Luminanzsignals; gekennzeichnet durch die Kombination

einer einen ersten (A), einen zweiten (A') und einen dritten (B) Eingang sowie einen ersten und einen zweiten Ausgang aufweisenden Schaltungsvorrichtung (83) zum wahlweisen Verbinden ihres ersten und zweiten Ausganges mit ihrem ersten bzw. zweiten Eingang oder alternativ ihres ersten und zweiten Ausganges gleichzeitig mit ihrem dritten Eingang;

einer Einrichtung (31, 51, 75, 76, 77, 86, 87, 41), die zwischen den Eingangsanschluß und den ersten Eingang der Schaltungsvorrichtung gekoppelt ist und die Übertragungsfunktion

$$W(1+3z^{-1}+3z^{-2}+z^{-3})$$

aufweist, worin W ein Maßstabsfaktor ist;

einer Einrichtung (31, 51, 75, 76, 84, 85), die zwischen den Eingangsanschluß und den zweiten Eingang der Schaltungsvorrichtung gekoppelt ist und die Übertragungsfunktion

$$2+3z^{-1}+3z^{-2}+2z^{-3}$$

aufweist;

einer Einrichtung (31, 51, 75), die zwischen den Eingangsanschluß und den dritten Eingang der Schaltungsvorrichtung gekoppelt ist und die Übertragungsfunktion $z^{-1}(1+z^{-1})$ aufweist;

einer Signalkombiniereinrichtung (48), die einen ersten und einen zweiten Eingang sowie einen Ausgang, an dem ein verarbeitetes Luminanzsignal verfügbar ist, aufweist;

einer die Übertragungsfunktion z^{-1} aufweisenden Einrichtung (42) zum Koppeln des ersten Ausgang der Schaltungsvorrichtung mit dem ersten Eingang der Signalkombiniereinrichtung;

einer die Übertragungsfunktion

$$K(-1+2z^{-1}-z^{-2})$$

aufweisenden Einrichtung (43, 44, 45, 46, 47, 82) zum Koppeln des zweiten Ausgang der Schaltungsvorrichtung mit dem zweiten Eingang der Signalkombiniereinrichtung, wobei K ein Maßstabsfaktor ist.

13. Verarbeitungsschaltung nach Anspruch 12, dadurch gekennzeichnet, daß die Einrichtung zum Koppeln der Schaltungsvorrichtung mit dem zweiten Eingang der Signalkombiniereinrichtung außerdem eine adaptive Entkernungsschaltung (81, 82) enthält, die durch eine Entkernungssteuerschaltung (31, 51, 75 bis 80) gesteuert ist, die mit dem Eingangsanschluß gekoppelt ist und die Übertragungsfunktion

$$D(1+z^{-1})(1+z^{-2})^2$$

hat, wobei D ein Maßstabsfaktor ist.

Revendications

1. Circuit de traitement pour l'ajustement de l'amplitude dépendant de la fréquence de signaux vidéo numériques de luminance, caractérisé par la combinaison de:

un premier filtre FIR (31, 51) ayant un point d'entrée de réception de signaux vidéo numériques de luminance et ayant un point de sortie, ledit premier filtre FIR présentant une fonction de transfert cosinusoidale;

un second filtre FIR (32, 33, 34, 35, 38, 41, 42) ayant un point d'entrée couplé au point de sortie dudit premier filtre FIR et ayant un point de sortie, ledit second filtre FIR présentant une réponse en fréquence généralement passe-bas;

un troisième filtre FIR (33, 35, 36, 37, 39, 40, 43 à 47) ayant un point d'entrée couplé au point de sortie dudit premier filtre FIR et ayant un point de



sortie, et comprenant un circuit d'étalonnage variable (47) répondant aux signaux de réglage du gain (50), ledit troisième filtre FIR présentant une réponse en fréquence qui atténue le spectre relatif des hautes fréquences du signal de luminance moins que le spectre relatif des basses fréquences du signal de luminance; et

un moyen de combinaison (48) couplé aux points de sortie desdits second et troisième filtres FIR pour combiner des échantillons de signaux filtrés qui y sont produits, lesdits échantillons filtrés combinés (49) correspondant au signal vidéo numérique traité de luminance.

2. Circuit selon la revendication 1, caractérisé par:

ledit premier filtre FIR (31, 51) présentant la fonction de transfert

$$f1=1+z^{-1}$$

où z est la notation de la transformation z conventionnelle;

ledit second filtre FIR (32, 33, 34, 35, 38, 41, 42) présentant la fonction de transfert

$$f2=1/4(z^{-1}+2z^{-2}+z^{-3});$$

et

ledit troisième filtre FIR (33, 35, 36, 37, 39, 40, 43 à 47) présentant la fonction de transfert

$$f3=K(-2+3z^{-1}-2z^{-2}+3z^{-3}-2z^{-4})$$

où K est une constante.

3. Circuit selon la revendication 2, caractérisé en ce que ledit premier filtre FIR (31, 51) comprend un élément à retard (31) ayant un point d'entrée couplé à ladite source (30) et ayant un point de sortie et un circuit additionneur (51) ayant des premier et second points d'entrée couplés respectivement aux points d'entrée et de sortie dudit élément à retard, ledit circuit additionneur ayant un point de sortie correspondant au point de sortie dudit premier filtre FIR.

4. Circuit selon la revendication 2 ou 3, caractérisé en ce que le second filtre FIR (32, 33, 34, 35, 38, 41, 42) comprend:

des premier (33) et second (35) éléments à retard connectés en cascade ayant des points respectifs de sortie, le premier élément à retard ayant un point de sortie couplé au point de sortie du premier filtre FIR;

un premier moyen de pondération (34) couplé au point de sortie du premier élément à retard pour pondérer les échantillons de signal dudit premier élément à retard;

un moyen (32, 38) couplé au point d'entrée du premier élément à retard, au point de sortie du second élément à retard et audit premier moyen de pondération pour combiner des échantillons de signaux qui en sont disponibles;

un second moyen de pondération (41) couplé au moyen pour combiner les échantillons de signaux pour pondérer les échantillons combinés de signaux; et

un troisième élément à retard (42) ayant un point d'entrée couplé au second moyen de pondération et ayant un point de sortie qui correspond au point de sortie dudit second filtre FIR.

5. Circuit selon la revendication 2, 3 ou 4, caractérisé en ce que le troisième filtre FIR (33, 35, 36, 37, 39, 40, 43 à 47) comprend:

des premier (33) et second (35) éléments à retard connectés en cascade ayant des points respectifs de sortie, ledit premier élément à retard ayant un point de sortie couplé au point de sortie dudit premier filtre FIR;

des premier (36) et second (39) circuits de pondération respectivement couplés au point d'entrée du premier élément à retard et au point de sortie du second élément à retard pour la pondération des échantillons de signaux respectivement appliqués;

un moyen (37, 40) couplé aux premier et second circuits de pondération et au point de sortie du premier élément à retard pour combiner les échantillons de signal desdits circuits de pondération et ledit premier élément à retard;

des premier (44) et second (46) circuits de soustraction;

un troisième élément à retard (43) ayant un point de sortie et ayant un point d'entrée couplé audit moyen pour combiner les échantillons de signal;

des moyens respectifs pour coupler les points d'entrée et de sortie dudit troisième élément à retard au point d'entrée de diminueurs et de diminueuses respectivement dudit premier circuit de soustraction;

un quatrième élément à retard (45) ayant un point d'entrée couplé audit premier circuit de soustraction et ayant un point de sortie;

un moyen respectif pour coupler les points d'entrée et de sortie dudit quatrième élément à retard aux points d'entrée de diminueuses et de diminueurs respectivement dudit second circuit de soustraction; et

ledit circuit d'étalonnage variable comprend un circuit multiplicateur (47) ayant un point d'entrée (50) couplé au second circuit de soustraction et ayant un point de sortie correspondant au point de sortie d'un troisième circuit de traitement numérique.

6. Circuit selon la revendication 5, caractérisé en ce que le circuit multiplicateur (47) comprend:

un certain nombre de circuits déclenchés de pondération (60, 64; 61, 65; 62, 66; 63, 67) ayant des points respectifs d'entrée de données couplés au point d'entrée (80) dudit multiplicateur et ayant des bornes respectives d'entrée de commande (C1—C4), chacun desdits circuits déclenchés de pondération produisant au point respectif de sortie, des répliques pondérées des échantillons de signal appliqués audit point d'entrée pour un premier état logique appliqué à sa borne respective de commande ou des échantillons de valeur nulle pour un second état logique appliqué à sa borne respective de commande, et chacun desdits circuits déclenchés de pondération étant agencé pour pondérer les échantillons d'entrée de valeurs successivement décroissantes;



un moyen (68, 69, 70) pour combiner les échantillons de sortie de tous lesdits circuits déclenchés de pondération pour produire des répliques étagées d'échantillons appliqués audit circuit multiplicateur.

7. Circuit selon la revendication 6, caractérisé en ce que chacun desdits circuits déclenchés de pondération comprend:

une porte ET à $n+1$ entrées (64—67), n desdites entrées étant des entrées d'échantillons de signal et la $n+1$ ème entrée étant couplée à sa borne respective de commande (C1—C4); et

un moyen de décalage de bits (60—63) pour altérer l'importance des positions binaires de l'échantillon, ledit moyen de décalage de bits étant couplé entre les n entrées d'échantillons de signaux de la porte ET et le point d'entrée (80) du multiplicateur.

8. Circuit selon toute revendication précédente, caractérisé en ce que ledit moyen de combinaison (48) est couplé audit troisième filtre FIR (33, 35, 36, 37, 39, 40, 43, 44, 45, 46, 47) par un appareil comprenant:

un circuit de creusement (82) ayant un point d'entrée de valeurs de seuil, ledit circuit de creusement ayant un trajet de signaux connecté entre ledit troisième filtre FIR et ledit moyen de combinaison;

un moyen de commande numérique (81) ayant un point d'entrée couplé au point de sortie dudit troisième filtre FIR, pour développer des valeurs numériques de seuil et les appliquer au point d'entrée de valeurs de seuil dudit circuit de creusement; et

un quatrième filtre FIR (78, 79, 80) ayant un point d'entrée couplé au point de sortie dudit premier filtre FIR (31, 51) et un point de sortie couplé audit moyen de commande numérique, ledit quatrième filtre FIR présentant une réponse en fréquence passe-bas.

9. Circuit selon la revendication 8, caractérisé en ce que les fonctions de transfert f_4 du quatrième filtre FIR est donné par l'équation

$$f_4 = W(1+z^{-2})^2$$

où W est un facteur d'étalement.

10. Circuit selon la revendication 8 ou 9, caractérisé en ce que:

ledit moyen de commande numérique (81) comprend un moyen formant mémoire ayant un point de sortie de données couplé audit point d'entrée de valeurs de seuil et ayant un point d'entrée d'adresse, ledit moyen formant mémoire étant programmé pour produire des valeurs de seuil correspondant aux signaux appliqués d'adresse; et en ce que

le point de sortie dudit quatrième filtre FIR est couplé audit point d'entrée d'adresse.

11. Circuit selon la revendication 8, 9 ou 10, caractérisé en ce que

ledit circuit de creusement (82) a un point d'entrée couplé audit troisième filtre FIR (33, 35, 36, 37, 39, 40, 43 à 47) et un point de sortie couplé audit moyen (48) pour combiner les échantillons

de signal, ledit circuit de creusement comprenant un moyen de comparaison (130) pour comparer les échantillons de signal dudit troisième filtre FIR et lesdits signaux de seuil, ledit circuit de creusement (122—128) produisant lesdits échantillons de signal en tant qu'échantillons de sortie en réponse à un premier résultat de la comparaison et produisant un signal numérique prédéterminé en tant que signal de sortie en réponse à un second résultat de la comparaison.

12. Circuit de traitement pour l'ajustement de l'amplitude dépendant de la fréquence de signaux vidéo numériques de luminance, comprenant

un point d'entrée (30) pour appliquer ledit signal de luminance; caractérisé par la combinaison de:

un moyen de commutation (83) ayant des premier (A), second (A') et troisième (B) point d'entrée et des premier et second points de sortie pour sélectivement connecter ses premier et second points de sortie à ses premier et second points d'entrée respectivement ou alternativement connecter ses premier et second points de sortie simultanément à son troisième point d'entrée;

un moyen (31, 51, 75, 76, 77, 86, 87, 41) couplé entre ledit point d'entrée et ledit premier point d'entrée dudit moyen de commutation et présentant la fonction de transfert

$$W(1+3z^{-1}+3z^{-2}+z^{-3})$$

où W est un facteur d'étalement;

un moyen (31, 51, 75, 76, 84, 85) couplé entre ledit point d'entrée et le second point d'entrée dudit moyen de commutation et présentant la fonction de transfert

$$2+3z^{-1}+3z^{-2}+2z^{-3};$$

un moyen (31, 51, 75) couplé entre ledit point d'entrée et ledit troisième point d'entrée dudit moyen de commutation présentant la fonction de transfert

$$z^{-1}(1+z^{-1});$$

un moyen de combinaison de signaux (48) ayant des premier et second points d'entrée et ayant un point de sortie auquel est disponible le signal traité de luminance;

un moyen (42) présentant la fonction de transfert z^{-1} pour coupler le premier point de sortie dudit moyen de commutation au premier point d'entrée dudit moyen de combinaison de signaux;

un moyen (43, 44, 45, 46, 47, 82) pour coupler le second point d'entrée dudit moyen de commutation au second point d'entrée dudit moyen de combinaison de signaux, comprenant un montage présentant la fonction de transfert

$$K(-1+2z^{-1}-z^{-2})$$

où K est un facteur d'étalement.



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13. Circuit de traitement selon la revendication 12, caractérisé en ce que le moyen pour coupler le moyen de commutation au second point d'entrée dudit moyen de combinaison de signaux comprend de plus un circuit de creusement adaptif (81, 82) répondant au montage de commande de

creusement (31, 51, 75 à 80) couplé audit point d'entrée et présentant la fonction de transfert

$$D(1+z^{-1})(1+z^{-2})^2$$

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où D est un facteur d'étalonnage.

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