

Description

The present invention relates to reducing both noise and one of the chrominance or luminance components of a video signal.

The use of recursive filters for reducing noise in video signals is relatively well known. Video recursive filters typically consist of a frame memory, two scaling circuits and an adder circuit. Incoming or current video signal is scaled by one of the scaling circuits and the scaled video signal is applied to one input port of the adder. A signal delayed by substantially one frame period from the output of the frame memory is scaled in the other of the scaling circuits and applied to a second input port of the adder. Video signal sums produced by the adder are coupled to the input of the frame memory and represent noise-reduced video.

The foregoing description applies if the video signal is a monochrome or luminance signal. If the video signal is a chrominance component of composite video a signal chrominance phase inverter must be interposed between the adder circuit and the frame memory. Finally, if the video signal to be processed is composite video, and the desired system output signal is noise-reduced composite video signal, then circuitry must be inserted between the adder and frame memory to invert the phase of the chrominance component only, of the noise-reduced composite video signal. An example of this type of video recursive filter is disclosed in US-A-4,064,530 entitled "Noise Reduction System For Color Television".

A recursive filter, which does not have provision for chrominance phase inversion, and to which composite video is applied tends to produce a noise reduced luminance component with a small amount of residual chrominance contamination after the occurrence of a number of frame periods in which there is no interframe image motion. Thus, a video recursive filter may be employed to partially separate the luminance component from composite video signal for non-moving images. Such a system has limited utility. The present invention is defined in the appended claims.

One embodiment of the present invention provides luminance/chrominance separation from composite video signal without residual cross components using a recursive filter system.

Another embodiment adaptively controls a luminance/chrominance separating recursive filter to rapidly reach steady state operation following cessation of interframe image motion.

A further embodiment of the invention comprises a video signal recursive filter system which includes a delay or storage device for storing a noise-reduced video signal and a summing device for adding a portion of the stored signal to a portion of the current or incoming video signal to produce noise-reduced video signal. A signal combining circuit is arranged to subtract a further portion of current video signal from the noise-reduced video signal to produce a noise-reduced video signal having a predetermined component of the video signal substantially eliminated.

The invention will now be described by way of example with reference to the accompanying drawings in which:

FIGURES 1—3 are block diagrams of alternate embodiments of noise recursive filter systems embodying the present invention; and

FIGURE 4 is a block diagram of exemplary circuitry for generating scale factors for application to the scaling circuits in FIGURES 1—3.

Although the noise reducing system of the invention is useful for processing video signals developed in accordance with conventional TV signal standards, with e.g. appropriate selection of memory size, the invention will be described as applied to the NTSC television standard. It is to be understood that the system may be implemented in either the analog or the digital domain, however, a digital implementation of the system will be described. In the drawing, interconnections constructed with broad arrows represent multiconductor connections for parallel-bit digital signals. Interconnections drawn with narrow arrows represent single conductor connections.

Referring to FIGURE 1, digital video signal to be processed is applied to input port 10 and noise reduced signal is available at output port 28. The input video signal may be baseband composite video signal from an analog-to-digital converter (not shown) or it may be, for example, luminance signal with incompletely cancelled chrominance signal therein. For either input signal the output signal is noise-reduced luminance signal with the chrominance component removed.

The input video signal at input port 10 is coupled to a scaling circuit 14 which scales the input video signal by a factor $(1-K)$. The scaled input signal is coupled to one input port of adder 18. The output port of adder 18 is coupled to the input port of a delay or memory device 30 which delays signal by substantially one frame period wherein a frame comprises two fields of NTSC video signal. Delayed signal from memory 30 is coupled to scaling circuit 16 which scales the delayed signal by a factor K . The scaled and delayed signal is applied to a second input port of adder 18. The delay period provided by memory 30 is selected so that the two signals applied to adder 18 are separated in time by precisely one frame period (or a multiple of frame periods).

If the signals at input port 10, the output port of adder 18 and the output port of memory 30 are designated S_A , S_B and S_C respectively, then the signal S_B is given by

$$S_B = (1-K)S_A + KS_C. \quad (1)$$

The signal S_C is equal to the signal S_B generated during the previous frame period. Thus, if the current

frame is designated from n , and the current signal, S_B , is written as S_{Bn} , then the signal S_C is equal to the signal $S_{B(n-1)}$. The signal $S_{B(n-1)}$ is given by the equation

$$\begin{aligned} S_{B(n-1)} &= (1-K)S_{A(n-1)} + KS_{C(n-1)} \\ &= (1-K)S_{A(n-1)} + KS_{B(n-2)} \end{aligned} \quad (2)$$

and the signals $S_{B(n-1)}$ may be expressed in similar fashion. Substituting the values of $S_{C(n-1)}$ into equation (1) produces the result

$$S_{Bn} = (1-K)S_{An} + K(1-K)S_{A(n-1)} + K^2(1-K)S_{A(n-2)} + \dots K^i(1-K)S_{A(n-i)} + \dots \quad (3)$$

If the input signal S_A is composite video signal, it consists of luminance, Y , chrominance, C and noise, N , components so that the signal S_A is more properly represented

$$S_A = Y_A + C_A + N_A \quad (4)$$

and each component should be evaluated separately with respect to equations (1)–(3). The luminance component, for a given pixel, in the absence of interframe motion, has in fact the same value from frame to frame. Substituting the Y component of the samples for S in equation (3), and since all of the $Y_{A(n-i)}$ samples will be equal for no motion, equation (3) reduces to

$$Y_B = Y_A(1-K)(1+K+K^2+K^3+K^4+\dots). \quad (5)$$

As n gets large, the series reduces to $1/(1-K)$ and equation (5) becomes

$$Y_B = Y_A(1-K)/(1-K) = Y_A. \quad (6)$$

The chrominance component is 180 degrees out of phase from frame to frame. If values for the chrominance component C_i are substituted for the sample value S_i in equation (3) the polarity of the terms in the series alternate. For the chrominance component equation (3) reduces to

$$C_B = C_A(1-K)(1-K+K^2-K^3+\dots K^n+\dots). \quad (7)$$

In the limit as the number K^n terms approach infinity the series with alternating signs tends towards the value $1/(1+K)$. Substituting this value for the series in equation (7), in the limit becomes the chrominance component

$$C_B = C_A(1-K)/(1+K) \quad (7)$$

which for K approaching 1 becomes small but is significant if it contaminates a luminance signal.

Noise is considered differently since noise samples from frame to frame are not coherent regardless of the state of interframe image motion or non-motion. The assumption is made that the noise components of all of the samples have approximately equal RMS values. Noise power adds as the sum of the squares of the respective noise components and the RMS amplitude is the square root of the sum of the squares. The noise value N_B is determined by substituting the noise component samples into equation (3) with each term squared. After simplifying, the result is

$$N_B(\text{RMS}) = N(\text{RMS})(1-K)\sqrt{1+K^2+K^4+K^6+K^{2n}}. \quad (9)$$

The series under the radical for n large approaches the value $1/(1-K^2)$ so that equation (9) reduces to

$$N_B(\text{RMS}) = N(\text{RMS})\sqrt{(1-K)/(1+K)}. \quad (10)$$

The luminance signal to noise improvement at point B in the FIGURE 1 circuit approaches $\sqrt{(1+K)/(1-K)}$ which is large for K approaching 1.

The residual chrominance signal is removed from the noise-reduced luminance signal by combining a portion of the input chrominance component with the noise-reduced signal. This is accomplished in the FIGURE 1 circuit by applying the input signal at port 10 to the filter 20 which passes only those signal components in the band of frequencies normally occupied by chrominance signal. The chrominance signal from filter 20 is scaled in element 22 by the factor $(K-1)/(1+K)$ and then combined with the noise reduced luminance in adder 24.

The residual chrominance in the luminance signal has an amplitude of $C_{in}(1-K)/(1+K)$ from equation (8) while the chrominance signal from element 22 is $C_{in}(K-1)/(1+K)$ which, when the two are additively combined, cancel leaving noise reduced luminance. Note that delay element 26 coupling signal from adder 18 to adder 24 compensates for sample processing delays incurred in filter 20.

The foregoing analysis assumed that there was no interframe image motion. When motion occurs it is

generally accepted that a recursive filter produces undesirable results. In the FIGURE 1 system recursive filtering is inactivated when interframe image motion is detected. This is accomplished by changing the value of K to zero which effectively disconnects the feedback from memory 30 and couples input signal from port 10 via adder 18 to adder 24 scaled by the factor "1" and via filter 20 to adder 24 scaled by the factor "-1". The chrominance component at point B is in phase with the chrominance component of the signal output of filter 20. The in-phase chrominance from filter 20 is subtracted from the chrominance component in the signal passed by adder 18 leaving only a luminance component and a noise component on output bus 28. The FIGURE 1 circuit operates as a band stop filter to eliminate the chrominance component from the input video signal during motion.

Band-pass filter 20 is incorporated to provide low-pass filter luminance during motion intervals. However, during non-motion intervals filter 20 is not necessary to the circuit. In these intervals, the input signal may be coupled directly to scaling circuit 22. In this instance the amplitude of the luminance component at output port 28 is reduced from the amplitude of the luminance component of the input signal. The amplitude of the luminance component at output 28 can be restored by appropriately amplifying the output signal.

Generally the signal-to-noise ratio of video signals is sufficiently acceptable so the viewer will readily tolerate a time interval for the system to converge to the desired signal-to-noise improvement. This is not so with regard to chrominance contamination of luminance signal. The elimination of chrominance should be realizable during the first frame of no image motion. The first frame of no image motion is defined herein as the frame period in which the image content of the current input frame is the same as the image content of the immediately preceding frame. This criterion is applied on a pixel basis. In other words, with regard to the overall image there may be areas of interframe image motion. However, each pixel, frame-to-frame, is processed independently of all other pixels. The term "frame of no image motion" thus applies to each pixel independently of the condition of motion or non motion of other pixels.

The elimination of chrominance may be accomplished if the chrominance component at point B is forced to converge to a steady state value in the first frame of no motion. This condition is achieved with the use of three values of K for scaling circuits 14 and 16; the first value, K_1 , is used during image motion; the second value, K_2 , is used during the first frame of no motion and the third value, K_3 , is used for all succeeding frames of no motion. The value of K_1 is equal to zero to inactivate the recursive filter part of the system and to lead incoming signal directly to the frame memory to insure that information is available to detect the cessation of motion. The value of K_2 is selected to provide the desired steady state signal-to-noise improvement. The selection of K_2 involves a trade-off between the extent of signal-to-noise achievable, and the time required to achieve it and also the subjective difference between the signal-to-noise ratio of moving image objects versus that of non moving image objects. The value K_2 required to produce a steady state chrominance component at point B and consequently to permit elimination of chrominance in all frames of no motion is given by

$$K_2 = 1/1+K_3 \quad (9)$$

Only two values are required for the scale factor K in the scaling circuit 22 and these values are zero for motion periods and K_3 for all non-motion periods.

The scale factors are selected at the pixel rate or a small submultiple of the pixel rate. The values of K are dependent on interframe motion and the history of interframe motion.

Differences between the luminance component of samples from successive frames are an indication that motion or no motion has occurred between frames. These differences are provided by subtractor 13 having its minuend and subtrahend inputs connected to the input port 10 and the output of memory 30. The differences are coupled to a motion detector-scale factor generator 12 which produces the respective scale factors for scaling circuits 14, 16 and 22. All illustrative motion detector scale factor generator will be described below with reference to FIGURE 4.

FIGURE 2 is an alternative recursive filter noise reducing system. Input video samples, S_A , are applied at input port 10 and coupled to subtractor 40. Delayed samples S_E , from memory 30, are coupled to a second input port of subtractor 40 which produces the difference samples $(S_A - S_E)$. The respective samples S_A and S_E correspond to like pixels of successive image frames. The difference samples $(S_A - S_E)$ are applied to a scaling circuit 48 which produces scaled difference samples $K_m(S_A - S_E)$ where K_m is a scale factor. The scaled difference samples and the delayed samples S_E are applied to an adder 50 which produces sample sums S_D given by the equation

$$\begin{aligned} S_D &= K_m(S_A - S_E) + S_E \\ &= K_m S_A + S_E(1 - K_m). \end{aligned} \quad (11)$$

During periods of interframe image motion the scale factor K_m is set to one and from equation (11) it is seen that the samples S_D are equal to the input samples S_A . After e.g. two frames of no motion the scale factor K_m is set to a value K_{m3} . If no motion persists for a relatively large number of frame intervals it can be shown that the noise component S_{Dn} at the output of adder 50 converges to the value

$$S_{DN}(RMS) = S_N(RMS) \sqrt{K_{m3}/(2-K_{m3})} \quad (12)$$

To insure that the chrominance component converges to a steady state value at the first frame of no motion, the scale factor K_m is set to a value K_{m2} during the first frame of no motion. The value of K_{m2} is given by

$$K_{m2} = 1/(2-K_{m3}) \quad (13)$$

and the steady state chrominance component S_{DC} is given by

$$S_{DC} = S_{AC} K_{m3}/(2-K_{m3}) \quad (14)$$

The luminance component S_{DY} , in the steady state, is equal to the luminance component at the input S_{AY} .

Input samples at port 10 are applied to a chrominance band-pass filter 44 which passes the chrominance component S_{AC} , a luminance component S_{AYH} which corresponds to the luminance signal in the chrominance band of frequencies, and a noise component to a scaling circuit 46 which scales the samples by a factor K_0 . The scaled samples $K_0(S_{AC}+S_{AYH}+S_{AN})$ are coupled to adder 52. Samples S_{DY} , consisting of components S_{DY} , S_{DC} and S_{DN} from adder 50, are coupled to a second input port of adder 52 which develops the system output signal S_0 given by

$$S_0 = S_{DY} + S_{DC} + K_0 S_{AC} + K_0 S_{AYH} + S_{ON} \quad (15)$$

The chrominance component of Samples S_0 are reduced to zero by setting the scale factor K_0 to the value $-K_{m3}/(2-K_{m3})$.

The lower frequency luminance component of samples S_0 is equal to the luminance component samples S_{DY} . The luminance component S_{DYH} of samples S_0 , in the chrominance frequency spectrum is equal to $S_{AYH}(2(1-K_{m3})/(2-K_{m3}))$. This is an undesirable reduction in high frequency luminance but, the amplitude may be restored by selectively peaking the output signal.

The noise component S_{ON} is developed from noise contributions passed through scaling circuit 46 and from the output of adder 50. Assuming the worst case i.e. that band-pass filter 44 passes all of the input noise component, the output noise component can be shown to be

$$S_{ON}(RMS) = S_{AN}(RMS) \sqrt{2K_{m3}(1-K_{m3})/(2-K_{m3})} \quad (16)$$

The ratio of the output noise component S_{ON} to the noise component S_{ON} is equal to $\sqrt{2(1-K_{m3})/(2-K_{m3})}$ which is less than 1 for all values of K_{m3} less than 1.

In the FIGURE 2 system the difference samples produced by subtractor 40 contain interframe motion information. These differences are applied to a motion detector-scale factor generator circuit 42 which develops the scale factors for scaling circuits 46 and 48 on e.g. a pixel-by-pixel basis i.e. a sample-by-sample basis. Illustrative scale factors produced by circuits 42 are in Table I.

TABLE I

MOTION	FRAME	K_m	K_0
Yes	X	1	-1
No	1 st after motion	$1/(2-K_{m3})$	$-K_{m3}/(2-K_{m3})$
No	n th after motion	K_{m3}	$-K_{m3}/(2-K_{m3})$

In Table I, the value K_{m3} will be some small value such as $\frac{1}{4}$, $\frac{1}{8}$ or $\frac{1}{32}$.

The FIGURE 2 system like the FIGURE 1 system reverts to a chrominance band stop or notch filter between the input and output ports during motion intervals.

FIGURE 3 is a variation of the FIGURE 2 system. Elements of the FIGURE 3 circuit designated with like numbers to the FIGURE 2 circuit are similar devices.

In FIGURE 3 sample differences $(S_A - S_E)$ from subtractor 40 are applied to scaling circuit 62 which produces scaled sample differences $K_K(S_A - S_E)$. The scaled sample differences are coupled to adder 70 wherein they are summed with samples S_E from frame memory 30. The sums, S_X , from adder 70, in the absence of motion, are coupled unchanged via subtractor 68 to the luminance output port 72 and are expressed by

$$\begin{aligned} S_X &= K_K(S_A - S_E) + S_E \\ &= K_K S_A + (1 - K_K) S_E \end{aligned} \quad (17)$$

In the absence of motion, the luminance component of S_A is equal to the luminance component of S_E . From equation (16) it is seen therefore, that the output luminance component S_{XY} is equal to the input luminance component S_{AY} regardless of the value of K_K . The higher frequency luminance component output by adder 70 are not attenuated as are the higher frequency luminance components output by the

FIGURES 1 and 2 circuits. In the first frame of no motion K_K is set to one-half. The magnitude of the chrominance components of S_A and S_E will be equal but they will be anti-phase. Thus, during this frame interval the system performs as a luminance frame comb filter and the chrominance component output by adder 70 is zero.

If the value of K_m for the first frame of no motion is selected to cause the chrominance component of S_D to converge immediately, then with respect to the chrominance component S_{XC} in the second frame of no motion, equation (17) becomes

$$\begin{aligned} S_{XC} &= K_K S_{AC} + (1 - K_K) S_{EC} \\ &= K_K S_{AC} + (1 - K_K) (-K_{m3}/(2 - K_{m3})) S_{AC} \end{aligned} \quad (18)$$

The chrominance component S_{XC} will equal zero for K_K equal to one-half for the first frame of no motion and $K_{m3}/2$ for all succeeding frames of no motion.

The RMS value of the noise component S_{XN} converges toward the RMS input noise value times the square root of $(K_{m3}/2)$, which is smaller than the value of the noise component of the samples S_D for small K_{m3} and approaches the value $1/\sqrt{2}$ times the noise component of sample S_D for $K_{m3}=1$. The noise component S_{XN} for the first frame of no motion is equal to the RMS value of the input noise divided by the square root of two.

The value of the scale factor K_K is set to "1" during interframe image motion. From equation (17) it is seen that the output signal S_X is equal to the input signal S_A . Similarly from equation (11) the signal S_D is equal to S_A (for $K_m=1$). The signal S_D is applied to a band-pass filter 64 which extracts the chrominance component. The chrominance component $S_{DC}=S_{AC}$ is coupled during interframe image motion periods to the subtrahend input of subtractor 68 by the gating circuit 66. The chrominance component of signal S_X is cancelled in subtractor 68 by the chrominance signal component S_{DC} . The control for gating circuit 66 may be provided by the motion detector 60. In effect, the FIGURE 3 circuit reverts to a band stop filter for chrominance signal during image motion.

Chrominance signal with a reduced luminance component may be developed by subtracting the luminance output signal S_{XY} from appropriately delayed composite video signal from input 10. It is noted that during no motion periods the difference signals from subtractor 40 consists substantially of a chrominance signal whose amplitude is slightly larger than the amplitude of the input chrominance component.

Table II lists the scale factors K_m and K_K as well as the gate control for the different conditions of interframe image motion for the FIGURE 3 system.

TABLE II

MOTION		FRAME	K_m	K_K	GATE 66 CONTROL
Yes	X				
No	1 st	frame no motion	$1/(2 - K_{m3})$	1/2	OFF
No	n th	frame no motion	K_{m3}	$K_{m3}/2$	OFF

The FIGURE 3 circuitry may be slightly rearranged to provide a further alternative embodiment. In such alternate embodiment the signal input port of the scaling circuit 62 may be coupled to the output of scaling circuit 48 rather than the output of subtractor 40. The values of the scale factor K_K must be appropriately changed so that the product of scale factors, $K_m K_K$, equal the respective values in Table II listed under the column headed K_K . For example, new values of K_K are 1, $(2 - K_{m3})/2$ and $1/2$ for no motion, the first frame post motion and steady state respectively.

In designing the FIGURE 1—3 systems it may be necessary to interpose compensating delays in certain of the signal paths. Those skilled in the art of circuit design will readily recognize such requirements and be able to implement them.

The systems have been described in terms of primarily producing a noise-reduced luminance signal from composite video signal or from a luminance input signal containing chrominance contamination. With slight alterations the system can be arranged to, for example, produce a noise reduced chrominance signal from composite video. This may be accomplished in the FIGURE 3 system by changing subtractor 40 to an adder and adders 50 and 70 to subtractors.

This may be understood by assuming that the composite video signal is sampled synchronous to the

color burst reference and at four times the color subcarrier frequency. If the sampling phase is selected to coincide with the I and Q color difference signal axes the sequence of samples may be represented Y_1-I_1 , Y_2+Q_2 , Y_3+I_3 , Y_4-Q_4 , Y_5-I_5 , Y_6+Q_6 , Y_7+I_7 , Y_8-Q_8 , ... Corresponding samples on adjacent frame, because chrominance is inverted, may be represented Y_1+I_1 , Y_2-Q_2 , Y_3-I_3 , Y_4+Q_4 , Y_5+I_5 , Y_6-Q_6 , Y_7-I_7 , Y_8+Q_8 , ... If the luminance and I, Q magnitudes of corresponding samples in the two sequences (frames) are equal (i.e. for no interframe motion), and the samples from the first sequence are added to corresponding samples in the second sequence, the luminance components, Y, will combine constructively but the I, Q components will cancel. The system of FIGURE 3 operates on the principle to produce the luminance output signal. In FIGURE 3, the first sequence may be considered to correspond to the samples S_A and the second sequence to correspond to samples S_B .

Now consider complementing (inverting) the samples in the second sequence. The complemented sequence will have relative values represented by $-(Y_1+I_1)$, $-(Y_2-Q_2)$, $-(Y_3-I_3)$, $-(Y_4+Q_4)$, $-(Y_5+I_5)$, $-(Y_6-Q_6)$, $-(Y_7-I_7)$, $-(Y_8+Q_8)$, ... which may be rewritten $-I_1-Y_1$, Q_2-Y_2 , I_3-Y_3 , $-Q_4-Y_4$, $-I_5-Y_5$, Q_6-Y_6 , I_7-Y_7 , $-Q_8-Y_8$, ... Comparing this latter sequence with the first sequence it will be seen that corresponding I, Q component samples are all in phase i.e. have like polarities while the luminance component samples have opposite polarity. Thus, if the complemented version is applied as signal S_B in the FIGURE 3 system, the I, Q components will combine constructively and the luminance component will cancel. The effect of complementing the signal S_B , i.e. the output of frame memory 30 may be realized by complementing the inputs to subtractor 40 and adders 50 and 70 to which the samples S_B are coupled. But this is the same as changing subtractor 40 to an adder, and adders 50 and 70 to subtractors with the samples S_B coupled to subtrahends to the subtractors.

The chrominance signal i.e. the I and Q color difference signals, has significantly less bandwidth than the luminance signal. In a recursive filter arranged to produce the chrominance signal it is therefore not necessary to use all of the samples of the foregoing sequences and, thus, the size of the frame memory 30 can be reduced. For example two samples, one containing an I component and one containing a Q component, from each set of four successive samples may be selected and processed. If this is done, however, provision must be made to select samples of opposite I, Q phase in alternate frames. For example, if the samples Y_1-I_1 , Y_2+Q_2 , Y_5-I_5 , Y_6+Q_6 etc. are selected from the first sequence than samples Y_1+I_1 , Y_2-Q_2 , Y_5+I_5 , Y_6-Q_6 etc. must be selected from the second sequence.

Similar modifications can be made to the FIGURE 1 and 2 systems.

FIGURE 4 shows an illustrative motion detector-scale factor generator. The circuitry shown is directed toward FIGURE 3 system but with modifications that will be immediately apparent to those skilled in the art of circuit design can be made applicable to the FIGURE 1 and 2 systems.

Sample differences from subtractor 40 are applied to a low-pass filter 80 to remove the chrominance component. This is necessary since chrominance has a 180 degree phase difference from frame-to-frame and, thus, combines constructively in subtractor 40 rather than providing the difference of the chrominance magnitudes. The low-pass filtered differences are applied to a threshold detector 82 which generates a logic one for the magnitude, i.e. the absolute value, of the differences being greater than a predetermined value and generates a logic zero for the magnitude of the differences being less than this value. The predetermined value or threshold is established to provide a degree of noise immunity in the detection of motion and will be determined by user or designer preference.

Motion signal from detector 82 is coupled to the data input port of the memory device 84 which delays the motion signal by one frame period. Delayed motion signal from the memory device 84 and motion signal from the detector 82 are coupled to the address input ports of the ROM's 86 and 88 which are programmed to output the requisite scale factors for the motion states applied to their address input ports. Table III is an illustrative state table for the FIGURE 3 system.

TABLE III

		DETECTOR		MEMORY			
		82	84	GATE			
FRAME	MOTION	OUTPUT	OUTPUT	CONTROL	K_m	K_K	
N-3	YES	1	X	ON	1	1	
N-2	YES	1	1	ON	1	1	
N-1	NO	0	1	OFF	$1/(2-K_{m3})$	$1/2$	
N	NO	0	0	OFF	K_{m3}	$K_{m3}/2$	
N+1	YES	1	0	ON	1	1	

Table III is developed around a time sequence of frames running from top to bottom. The condition of interframe image motion was selected to provide all possible 2-bit address states to the ROM's 86 and 88. The columns labeled "Detector 82 Output" and "Memory 84 Output" taken together form the address

codes for the ROM's 86 and 88. Note the value K_{m3} is selected arbitrarily in accordance with the desired system response time and degree of noise reduction.

For adaptation to the FIGURES 1 and 2 noise-reducing systems, ROM's 86 and 88 will be programmed with the appropriate scale factors or scale factor control signals as described with reference to FIGURES 1 and 2 systems.

Claims

1. A recursive filter system, for processing video signals including luminance and chrominance components and noise, which video signal is formatted in frame periods, characterized by
 - a recursive filter (18, 30) for combining a portion of current video signal with a portion of combined signal from previous frames of video signal and which develops a processed video signal (B) wherein the amplitude of said noise is reduced, and the amplitude of one of the processed luminance and chrominance components of said video signal is substantially reduced with respect to the amplitude of the other of said processed luminance and chrominance components; and
 - signal cancelling means (20—26) for combining a portion of current video signal with a portion of said processed video signal from said recursive filter to substantially cancel the one of said processed luminance and chrominance components which is substantially reduced and developing an output signal (28) wherein the signal-to-noise ratio of the other of said luminance and chrominance components is enhanced with respect to current video signal.
2. The system set forth in Claim 1 characterized in that the recursive filter comprises:
 - delay means (30) having input and output ports for delaying signal by substantially one frame period;
 - signal combining means (18) having an output coupled to the input port of said delay means and having first and second input ports;
 - a first variable scaling circuit (16) having an input port coupled to the output port of said delay means and an output port coupled to one of the input ports of said combining means, and having a control input port;
 - a second variable scaling circuit (14) having an input port for receiving current video signal, an output port coupled to the other input port of said combining means and having a control input port; and
 - a motion responsive scale factor generating circuit (12, 13) responsive to current video signal and delayed signal from said delay means for developing control signals corresponding to scale factors K and $(1-K)$ for application to the respective control input ports of said first and second variable scaling circuit and wherein k is selected to have one value when motion is detected and at least one other value in the absence of motion.
3. The system set forth in claim 2 characterized in that said signal cancelling means (20—26) comprises:
 - a further combining means (24) having an output port from which noise reduced video signal is available, having a first input port coupled to the output port of said signal combining means, and having a second input port;
 - a third variable scaling circuit (22) having a control input port coupled to said scale factor generating circuit (12), having an output port coupled to the second input port of said further signal combining means and having an input port coupled to receive said current video.
4. The system set forth in claim 3 characterized in that the input port of said third variable circuit (22) is coupled to receive said current video input circuit via a filter for attenuating signal frequencies outside the band of frequencies normally occupied by said chrominance component.
5. The system as set forth in claim 3 characterized in that said scale factor generating means (12) applies control signals corresponding to scale factors including 0, 1 and -1 to the first, second and third scaling circuits (16, 14, 22) respectively, when motion is detected and scale factors of K , $1-K$ and $(K-1)/(K+1)$ to the first, second and third scaling circuits respectively for frame periods of no motion where K is a value less than one.
6. The system set forth in claim 5 characterized in that said scale factor generating means (12) applies control signals corresponding to scale factors of $1/(1+K_3)$, $K_3/(1+K_3)$ and $(K_3-1)/(K_3+1)$ to the first, second and third scaling circuits for the first frame of no motion where K_3 has a value less than 1.
7. The system set forth in claim 1 characterized in that said recursive filter comprises: delay means (30) having input and output ports, said delay means for delaying signals by substantially a multiple including one, of frame periods;
 - first signal combining means (50) having a first input port coupled to the output port of said delay means, having an output port coupled to the input port of said delay means and having a second input port;
 - a variable scaling circuit (48) having a control input port for receiving control signals corresponding to scale factors, and having an output port coupled to the second input port of said first signal combining means (50);
 - a second signal combining means (40) having a first input port for receiving said video signal, a second input port coupled to the output port of said delay means (30) and having an output port coupled to the input port of scaling circuit (48); and
 - a motion detector (42) having an input port coupled to the output port of said second signal combining

codes for the ROM's 86 and 88. Note the value K_{m3} is selected arbitrarily in accordance with the desired system response time and degree of noise reduction.

For adaptation to the FIGURES 1 and 2 noise-reducing systems, ROM's 86 and 88 will be programmed with the appropriate scale factors or scale factor control signals as described with reference to FIGURES 1 and 2 systems.

Claims

1. A recursive filter system, for processing video signals including luminance and chrominance components and noise, which video signal is formatted in frame periods, characterized by
 - a recursive filter (18, 30) for combining a portion of current video signal with a portion of combined signal from previous frames of video signal and which develops a processed video signal (B) wherein the amplitude of said noise is reduced, and the amplitude of one of the processed luminance and chrominance components of said video signal is substantially reduced with respect to the amplitude of the other of said processed luminance and chrominance components; and
 - signal cancelling means (20—26) for combining a portion of current video signal with a portion of said processed video signal from said recursive filter to substantially cancel the one of said processed luminance and chrominance components which is substantially reduced and developing an output signal (28) wherein the signal-to-noise ratio of the other of said luminance and chrominance components is enhanced with respect to current video signal.
2. The system set forth in Claim 1 characterized in that the recursive filter comprises:
 - delay means (30) having input and output ports for delaying signal by substantially one frame period;
 - signal combining means (18) having an output coupled to the input port of said delay means and having first and second input ports;
 - a first variable scaling circuit (16) having an input port coupled to the output port of said delay means and an output port coupled to one of the input ports of said combining means, and having a control input port;
 - a second variable scaling circuit (14) having an input port for receiving current video signal, an output port coupled to the other input port of said combining means and having a control input port; and
 - a motion responsive scale factor generating circuit (12, 13) responsive to current video signal and delayed signal from said delay means for developing control signals corresponding to scale factors K and $(1-K)$ for application to the respective control input ports of said first and second variable scaling circuits and wherein k is selected to have one value when motion is detected and at least one other value in the absence of motion.
3. The system set forth in claim 2 characterized in that said signal cancelling means (20—26) comprises:
 - a further combining means (24) having an output port from which noise reduced video signal is available, having a first input port coupled to the output port of said signal combining means, and having a second input port;
 - a third variable scaling circuit (22) having a control input port coupled to said scale factor generating circuit (12), having an output port coupled to the second input port of said further signal combining means and having an input port coupled to receive said current video.
4. The system set forth in claim 3 characterized in that the input port of said third variable circuit (22) is coupled to receive said current video input circuit via a filter for attenuating signal frequencies outside the band of frequencies normally occupied by said chrominance component.
5. The system as set forth in claim 3 characterized in that said scale factor generating means (12) applies control signals corresponding to scale factors including 0, 1 and -1 to the first, second and third scaling circuits (16, 14, 22) respectively, when motion is detected and scale factors of K , $1-K$ and $(K-1)/(K+1)$ to the first, second and third scaling circuits respectively for frame periods of no motion where K is a value less than one.
6. The system set forth in claim 5 characterized in that said scale factor generating means (12) applies control signals corresponding to scale factors of $1/(1+K_3)$, $K_3/(1+K_3)$ and $(K_3-1)/(K_3+1)$ to the first, second and third scaling circuits for the first frame of no motion where K_3 has a value less than 1.
7. The system set forth in claim 1 characterized in that said recursive filter comprises: delay means (30) having input and output ports, said delay means for delaying signals by substantially a multiple including one, of frame periods;
 - first signal combining means (50) having a first input port coupled to the output port of said delay means, having an output port coupled to the input port of said delay means and having a second input port;
 - a variable scaling circuit (48) having a control input port for receiving control signals corresponding to scale factors, and having an output port coupled to the second input port of said first signal combining means (50) a second signal combining means (40) having a first input port for receiving said video signal, a second input port coupled to the output port of said delay means (30) and having an output port coupled to the input port of scaling circuit (48); and
 - a motion detector (42) having an input port coupled to the output port of said second signal combining



means (40) for generating control signals which are coupled to said scaling means (48); and wherein noise reduced video signal (D) (E) is available from the output ports of said first combining means (50) and said delay means (30).

8. The system set forth in claim 7 characterized in that said signal cancelling means includes:

a further scaling circuit (46) having an input port for receiving said video signal, having a control input port coupled to said motion detector (42) for receiving control signals corresponding to scale factors, and having an output port; and

a further signal combining means (52) having a first input port coupled to the output port of said first signal combining means (50), a second input port coupled to the output port of said further scaling circuit (46) and having an output port (54) at which noise reduced video signal is available wherein one of said luminance and chrominance components is substantially eliminated.

9. The system set forth in claim 8 characterized in that said video signal is coupled to the input port of said further scaling circuit (46) via a filter (44) having a pass-band for passing frequencies normally occupied by said chrominance component.

10. The system set forth in claim 8 or 9 characterized in that said motion detector (42) applies control signals corresponding to scale factors including 1 and -1 to said scaling circuit (48) and said further scaling circuit (46) respectively when motion is detected and K_3 and $-K_3/(2-K_3)$ to said scaling circuit and said further scaling circuit respectively when no motion is detected, and where the magnitude of K_3 is a value less than one.

11. The system set forth in claim 10 characterized in that said motion detector (42) applies control signals corresponding to scale factors $1/(2-K_3)$ and $-K_3/(2-K_3)$ to said scaling circuit (48) and said further scaling circuit (46) respectively for the first frame of no motion.

12. The system set forth in claim 7 characterized in that said signal cancelling means includes:

a further signal combining means (70) having a first input port coupled to the output port of said delay means (30) having a second input port and having an output port at which noise reduced video signal (X) is available which noise reduced video signal has one of said luminance and chrominance components substantially eliminated; and

a further scaling circuit (62) having a control input port coupled to said motion detector (60) for receiving control signals corresponding to scale factors, having an output port coupled to the second input port of said further signal combining means (70), and having an input port coupled to the output port of said second signal combining means (40).

13. The system set forth in claim 12 characterized in that said motion detector (60) is configured to apply control signals corresponding to scale factors including 1 to the scaling circuit and further scaling circuit when motion is detected and K_3 and $K_3/2$ to the scaling circuit and further scaling circuit respectively when no motion is detected, and where the magnitude of K_3 is a value less than one.

14. The system set forth in claim 13 characterized in that said motion detector is configured to apply control signals corresponding to scale factors of $1/(2-K_3)$ and $1/2$ to said scaling circuit and said further scaling circuit respectively during the first frame of no motion.

Patentansprüche

1. Rekursive Filteranordnung zur Verarbeitung von Video-signalen, die Luminanz- und Chrominanzkomponenten und ein Rauschen enthalten und die in Bildperioden formatiert sind, gekennzeichnet durch ein rekursives Filter (18, 30) zum Kombinieren eines Teils des augenblicklich vorliegenden Videosignals mit einem Teil eines kombinierten Signals aus vorhergehenden Bildern des Videosignals, das ein verarbeitetes Videosignal (B) erzeugt, in dem die Amplitude des Rauschens vermindert ist und die Amplitude einer von den verarbeiteten Luminanz- und Chrominanzkomponenten des Videosignals wesentlich vermindert ist gegenüber der Amplitude der anderen von den verarbeiteten Luminanz- und Chrominanzkomponenten; und

eine Signalauslöschungseinrichtung (20—26) zum Kombinieren eines Teils des augenblicklich vorliegenden Videosignals mit einem Teil des verarbeiteten Videosignals von dem rekursiven Filter, um die eine von den verarbeiteten Luminanz- und Chrominanzkomponenten, die im wesentlichen vermindert ist, im wesentlichen auszulöschen und ein Ausgangssignal (28) zu erzeugen in dem das Signal/Rausch-Verhältnis der anderen von den Luminanz- und Chrominanzkomponenten gegenüber dem augenblicklich vorliegenden Videosignal verbessert ist.

2. Anordnung nach Anspruch 1, dadurch gekennzeichnet, daß das rekursive Filter folgendes enthält: eine Verzögerungseinrichtung (30) mit Eingangs- und Ausgangsanschlüssen zur Verzögerung des Signals um im wesentlichen eine Bildperiode;

eine Signalkombinierungseinrichtung (18) mit einem an den Eingangsanschluß der Verzögerungseinrichtung (30) gekoppelten Ausgang und einem ersten und einem zweiten Eingangsschluß;

eine erste variable Skalierschaltung (16) mit einem an den Ausgangsanschluß der Verzögerungseinrichtung gekoppelten Eingangsanschluß und einem an einen von den Eingangsanschlüssen der Kombinationseinrichtung gekoppelten Ausgangsanschluß und mit einem Steuereingangsanschluß;

eine zweite variable Skalierschaltung (14) mit einem Eingangsschluß zur Aufnahme des augenblicklich vorliegenden Videosignals, einem an den anderen Eingangsanschluß der Kombinationseinrichtung



gekoppelten Ausgangsanschluß und mit einem Steuereingangsanschluß; und

eine bewegungsempfindliche Skalierfaktor erzeugungsschaltung (12, 13), die auf das augenblicklich vorliegende Videosignal und ein verzögertes Signal von der Verzögerungseinrichtung anspricht, um Skalierfaktoren K und $(1-K)$ entsprechende Steuersignale zum Anlegen an die jeweiligen Steuereingangsanschlüsse der ersten und zweiten variablen Skalierschaltung zu erzeugen, wobei der Skalierfaktor K so gewählt ist, daß er einen Wert annimmt, wenn eine Bewegung festgestellt ist, und mindestens einen anderen Wert annimmt, wenn keine Bewegung vorliegt.

3. Anordnung nach Anspruch 2, dadurch gekennzeichnet, daß die Signalauslöschungseinrichtung (20-28) folgendes enthält:

eine weitere Kombinerungseinrichtung (24) mit einem Ausgangsanschluß, an dem ein rauschvermindertes Videosignal verfügbar ist, mit einem an den Ausgangsanschluß der Signalkombinerungseinrichtung gekoppelten ersten Eingangsanschluß und einem zweiten Eingangsanschluß;

eine dritte variable Skalierschaltung (22) mit einem an die Skalierfaktor erzeugungsschaltung (12) gekoppelten Steuereingangsschluß, einem an den zweiten Eingangsanschluß der weiteren Signalkombinerungseinrichtung gekoppelten Ausgangsanschluß und einem Eingangsanschluß zur Aufnahme des augenblicklich vorliegenden Videosignals.

4. Anordnung nach Anspruch 3, dadurch gekennzeichnet, daß der Eingangsanschluß der dritten variablen Skalierschaltung (22) geschaltet ist, das am Eingang augenblicklich vorliegenden Videosignal aufzunehmen über ein Filter zum Dämpfen von Signalfrequenzen außerhalb des normalerweise von der Chrominanzkomponente besetzten Frequenzbandes.

5. Anordnung nach Anspruch 3, dadurch gekennzeichnet, daß die Skalierfaktor erzeugungseinrichtung (12) der ersten zweiten bzw. dritten Skalierschaltung (16, 14, 22) jeweils den Skalierfaktoren, 0, 1 bzw. -1 entsprechende Steuersignale zuführt, wenn eine Bewegung festgestellt wird, und der ersten, zweiten bzw. dritten Skalierschaltung den Skalierfaktoren K , $1-K$ bzw. $(K-1)/(K+1)$ entsprechende Steuersignale zuführt für Bildperioden ohne eine Bewegung, wobei K einen Wert kleiner als 1 hat.

6. Anordnung Anspruch 5, dadurch gekennzeichnet, daß die Skalierfaktor erzeugungseinrichtung (12) der ersten, zweiten und dritten Skalierschaltung den Skalierfaktoren $1/(1+K_3)$, $K_3/(1+K_3)$ bzw. $(K_3-1)/(K_3+1)$ entsprechende Steuersignale für das erste Bild ohne Bewegung zuführt, wobei K_3 einen Wert kleiner als 1 hat.

7. Anordnung nach Anspruch 1, dadurch gekennzeichnet, daß das rekursive Filter folgendes enthält: eine Verzögerungseinrichtung (30) mit Eingangs- und Ausgangsanschlüssen, wobei die Verzögerungseinrichtung die Signale im wesentlichen um ein Vielfaches einschließlich 1 von Bildperioden verzögert;

eine erste Signalkombinerungseinrichtung (50) mit einem an den Ausgangsanschluß der Verzögerungseinrichtung gekoppelten ersten Eingang, einem an den Eingangsanschluß der Verzögerungseinrichtung gekoppelten Ausgangsanschluß und einem zweiten Eingangsanschluß;

eine variable Skalierschaltung (48) mit einem Steuereingangsschluß zur Aufnahme von Steuersignalen entsprechend Skalierfaktoren und einem mit dem zweiten Eingangsanschluß der ersten Signalkombinerungseinrichtung (50) gekoppelten Ausgangsanschluß;

eine zweite Signalkombinerungseinrichtung (40) mit einem ersten Eingangsanschluß zur Aufnahme des Videosignals, einem mit dem Ausgangsanschluß der Verzögerungseinrichtung (30) gekoppelten zweiten Eingangsanschluß und einem mit dem Eingangsanschluß der Skalierschaltung (48) gekoppelten Ausgangsanschluß; und

einen Bewegungsdetektor (42) mit einem an den Ausgangsanschluß der zweiten Signalkombinerungseinrichtung (40) gekoppelten Eingangsanschluß zum Erzeugen von Steuersignalen, die der Skaliereinrichtung (48) zugeführt werden; wobei ein rauschvermindertes Videosignal (D, E) von den Ausgangsanschlüssen der ersten Signalkombinerungseinrichtung (50) und der Verzögerungseinrichtung (30) verfügbar sind.

8. Anordnung nach Anspruch 7, dadurch gekennzeichnet, daß die Signalauslöschungseinrichtung folgendes enthält:

eine weitere Skalierschaltung (46) mit einem Eingangsanschluß zur Aufnahme des Videosignals, einem an den Bewegungsdetektor (42) gekoppelten Steuereingangsanschluß zur Aufnahme von Skalierfaktoren entsprechenden Steuersignalen und einem Ausgangsanschluß; und

eine weitere Signalkombinerungsschaltung (52) mit einem den Ausgangsanschluß der ersten Signalkombinerungseinrichtung (50) gekoppelten ersten Eingangsanschluß, einem an den Ausgangsanschluß der weiteren Skalierschaltung (46) gekoppelten zweiten Eingangsanschluß und einem Ausgangsanschluß (54), an welchem ein rauschvermindertes Videosignal verfügbar ist, in dem eine von dem Luminanz- und Chrominanzkomponenten in wesentlichen ausgelöscht ist.

9. Anordnung nach Anspruch 8, dadurch gekennzeichnet, daß das Videosignal an den Eingangsanschluß der weiteren Skalierschaltung (46) gekoppelt ist über ein Filter (44) mit einem Durchlaßband zum Durchlassen von normalerweise von der Chrominanzkomponente besetzten Frequenzen.

10. Anordnung nach Anspruch 8 oder 9, dadurch gekennzeichnet, daß der Bewegungsdetektor (42) der Skalierschaltung (48) bzw. der weiteren Skalierschaltung (46) den Skalierfaktoren 1 bzw. -1 entsprechende Steuersignale zuführt, wenn eine Bewegung festgestellt ist, und der Skalierschaltung bzw. der weiteren Skalierschaltung den Skalierfaktoren K_3 bzw. $-K_3/(2-K_3)$ entsprechende Steuersignale zuführt, wenn keine Bewegung festgestellt ist, wobei der Betrag von K_3 einen Wert von weniger als 1 hat.



11. Anordnung nach Anspruch 10, dadurch gekennzeichnet, daß der Bewegungsdetektor (42) der Skalierschaltung (48) bzw. der weiteren Skalierschaltung (46) den Skalierfaktoren $1/(2-K_3)$ bzw. $-K_3/(2-K_3)$ entsprechende Steuersignale für das erste Bild ohne Bewegung zuführt.

12. Anordnung nach Anspruch 7, dadurch gekennzeichnet, daß die Signalauslöschungseinrichtung
5 folgendes enthält:

eine weitere Signalkombinierungseinrichtung (70) mit einem an den Ausgangsanschluß der Verzögerungseinrichtung (30) gekoppelten ersten Eingangsanschluß, einem zweiten Eingangsanschluß und einem Ausgangsanschluß, an dem ein rauschvermindertes Videosignal (X) verfügbar ist, aus dem eine von den Luminanz- und Chrominanzkomponenten im wesentlichen ausgelöscht ist; und

10 eine weitere Skalierschaltung (62) mit einem an den Bewegungsdetektor (60) gekoppelten Steuerungseingangsanschluß zur Aufnahme von Skalierfaktoren entsprechenden Steuersignalen, mit einem an den zweiten Eingangsanschluß der weiteren Signalkombinierungseinrichtung (70) gekoppelten Ausgangsanschluß und einem an den Ausgangsanschluß der zweiten Signalkombinierungseinrichtung (40) gekoppelten Eingangsanschluß.

13. Anordnung nach Anspruch 12, dadurch gekennzeichnet, daß der Bewegungsdetektor (60) der Skalierschaltung und der weiteren Skalierschaltung dem Skalierfaktor 1 entsprechende Steuersignale zuführt, wenn eine Bewegung festgestellt ist, und der Skalierschaltung bzw. der weiteren Skalierschaltung den Skalierfaktoren K_3 bzw. $K_3/2$ entsprechende Steuersignale zuführt, wenn keine Bewegung festgestellt ist, wobei der Betrag von K_3 einen Wert kleiner als 1 aufweist.

14. Anordnung nach Anspruch 13, dadurch gekennzeichnet, daß der Bewegungsdetektor der Skalierschaltung bzw. der weiteren Skalierschaltung den Skalierfaktoren $1/(2-K_3)$ bzw. $1/2$ entsprechende Steuersignale während des ersten Bildes ohne Bewegung zuführt.

Revendications

1. Un système de filtre récurrent, pour traiter des signaux vidéo comprenant des composantes de luminance et de chrominance et du bruit, lequel signal vidéo est mis en forme en périodes d'image, caractérisé par:

un filtre récurrent (18, 30) pour combiner une portion du signal vidéo actuel à une portion d'un signal combiné d'images préalables du signal vidéo et qui produit un signal vidéo traité (B), où l'amplitude dudit bruit est réduite, et l'amplitude de l'une des composantes de luminance et de chrominance traitées dudit signal vidéo est sensiblement réduite par rapport à l'amplitude de l'autre composante de luminance et de chrominance traitée; et

un moyen de suppression de signal (20—26) pour combiner une portion du signal vidéo actuel à une portion du signal vidéo traité dudit filtre récurrent pour supprimer sensiblement l'une desdites composantes de luminance et de chrominance traitées qui est sensiblement réduite et produisant un signal de sortie (28), où le rapport signal-bruit de l'autre desdites composantes de luminance et de chrominance est amélioré par rapport au signal vidéo actuel.

2. Le système selon la revendication 1, caractérisé en ce que le filtre récurrent comprend:

un moyen à retard (30) ayant des bornes d'entrée et de sortie pour retarder un signal de sensiblement une période d'image;

un moyen de combinaison de signaux (18) ayant une sortie couplée à la borne d'entrée dudit moyen à retard et ayant des première et seconde bornes d'entrée;

un premier circuit multiplicateur variable (16) ayant une borne d'entrée couplée à la borne de sortie dudit moyen à retard et une borne de sortie couplée à l'une des bornes d'entrée du moyen de combinaison, et ayant une borne d'entrée de commande;

un second circuit multiplicateur variable (14) ayant une borne d'entrée pour recevoir un signal vidéo actuel, une borne de sortie couplée à l'autre borne d'entrée du moyen de combinaison et ayant une borne d'entrée de commande; et

un circuit (12, 13) de production de facteurs de multiplication répondant au mouvement, au signal vidéo actuel et au signal retardé du moyen à retard pour produire des signaux de commande correspondant aux facteurs de multiplication K et $(1-K)$ pour application aux bornes d'entrée de commande respectives desdits premier et second circuits de multiplication variables et où K est choisi pour avoir une valeur lorsque du mouvement est détecté et au moins une autre valeur en l'absence de mouvement.

3. Le système selon la revendication 2, caractérisé en ce que le moyen de suppression de signal précité (20—26) comprend:

un autre moyen de combinaison (24) ayant une borne de sortie de laquelle un signal vidéo à bruit réduit est disponible, ayant une première borne d'entrée couplée à la borne de sortie dudit moyen de combinaison de signaux, et ayant une seconde borne d'entrée;

un troisième circuit de multiplication variable (22) ayant une borne d'entrée de commande couplée au circuit de production de facteurs de multiplication (12), ayant une borne de sortie couplée à la seconde borne d'entrée dudit autre moyen de combinaison de signaux et ayant une borne d'entrée couplée pour recevoir le signal vidéo actuel.

4. Le système selon la revendication 3, caractérisé en ce que la borne d'entrée du troisième circuit



variable précité (22) est couplée pour recevoir le circuit d'entrée du signal vidéo réel via un filtre pour atténuer les fréquences du signal hors de la bande de fréquences normalement occupée par la composante de chrominance précitée.

5 5. Le système selon la revendication 3, caractérisé en ce que le moyen de production de facteurs de multiplication (12) applique des signaux de commande correspondant aux facteurs de multiplication comportant 0, 1 et -1 , respectivement aux premier, second et troisième circuits de multiplication (16, 14, 22) lorsque du mouvement est détecté et des facteurs de multiplication de K , $1-K$ et $(K-1)/(K+1)$ respectivement aux premier, second et troisième circuits de multiplication pour des périodes d'image d'absence de déplacement, où K est une valeur inférieure à un.

10 6. Le système selon la revendication 5, caractérisé en ce que le moyen de production de facteurs de multiplication (12) précité applique des signaux de commande correspondant aux facteurs de multiplication de $1/(1+K_3)$, $K_3/(1+K_3)$ et $(K_3-1)/(K_3+1)$ aux premier, second et troisième circuits de multiplication pour la première image d'absence de mouvement, où K_3 a une valeur inférieure à 1.

15 7. Le système selon la revendication 1, caractérisé en ce que le filtre récurrent précité comprend: un moyen à retard (30) ayant des bornes d'entrée et de sortie, ledit moyen à retard retardant les signaux de sensiblement un multiple comportant un, de périodes d'image;

un premier moyen de combinaison de signaux (50) ayant une première borne d'entrée couplée à la borne de sortie dudit moyen à retard, ayant une borne de sortie couplée à la borne d'entrée dudit moyen à retard et ayant une seconde borne d'entrée;

20 un circuit de multiplication variable (48) ayant une porte d'entrée de commande pour recevoir des signaux de commande correspondant aux facteurs de multiplication, et ayant une borne de sortie couplée à la seconde borne d'entrée dudit premier moyen de combinaison de signaux (50); un second moyen de combinaison de signaux (40) ayant une première borne d'entrée pour recevoir ledit signal vidéo, une seconde borne d'entrée couplée à la borne de sortie dudit moyen à retard (30) et ayant une borne de sortie couplée à la borne d'entrée du circuit de multiplication (48); et un détecteur de mouvement (42) ayant une borne d'entrée couplée à la borne de sortie dudit second moyen de combinaison de signaux (40) pour produire des signaux de commande qui sont couplés audit moyen de multiplication (48); et où un signal vidéo à bruit réduit (D) (E) est disponible des bornes de sortie dudit premier moyen de combinaison (50) et dudit moyen à retard (30).

30 8. Le système selon la revendication 7, caractérisé en ce que le moyen de suppression de signaux précité comprend:

un autre circuit de multiplication (46) ayant une borne d'entrée pour recevoir le signal vidéo précité, ayant une borne d'entrée de commande couplée au détecteur de mouvement précité (42) pour recevoir des signaux de commande correspondant aux facteurs de multiplication, et ayant une borne de sortie; et

35 un autre moyen de combinaison des signaux (52) ayant une première borne d'entrée couplée à la borne de sortie du premier moyen de combinaison de signaux précités (50), une seconde borne d'entrée couplée à la borne de sortie de l'autre circuit de multiplication (46) et ayant une borne de sortie (54) à laquelle un signal vidéo à bruit réduit est disponible où l'une des composantes de luminance et de chrominance est sensiblement éliminée.

40 9. Le système selon la revendication 8, caractérisé en ce que le signal vidéo précité est couplé à la borne d'entrée de l'autre précité circuit de multiplication (46) via un filtre (44) ayant une bande passante pour laisser passer les fréquences normalement occupées par la composante de chrominance précitée.

10. Le système selon la revendication 8 ou 9, caractérisé en ce que le détecteur de déplacement précité (42) applique des signaux de commande correspondant aux facteurs de multiplication comportant 1 et -1 au circuit de multiplication précité (48) et à l'autre circuit de multiplication précité (46), respectivement, lorsque du mouvement est détecté et K_3 et $-K_3/(2-K_3)$ audit circuit de multiplication et audit autre circuit de multiplication, respectivement, lorsqu'aucun déplacement n'est détecté, et où la grandeur de K_3 est une valeur inférieure à un.

11. Le système selon la revendication 10, caractérisé en ce que le détecteur de mouvement précité (42) applique des signaux de commande correspondant aux facteurs de multiplication $1/(2-K_3)$ et $-K_3/(2-K_3)$ au circuit de multiplication précité (48) et à l'autre circuit de multiplication précité (46) respectivement pour la première image d'absence de mouvement.

12. Le système selon la revendication 7, caractérisé en ce que le moyen de suppression de signaux précité comprend:

55 un autre moyen de combinaison de signaux (70) ayant une première borne d'entrée couplée à la borne de sortie du moyen à retard précité (30) ayant une seconde borne d'entrée et ayant une borne de sortie à laquelle un signal vidéo à bruit réduit (X) est disponible, lequel signal vidéo à bruit réduit a une des composantes précitées de luminance et de chrominance sensiblement éliminée; et

un autre circuit de multiplication (62) ayant une borne d'entrée de commande couplée au détecteur de mouvement précité (60) pour recevoir les signaux de commande correspondant aux facteurs de multiplication, ayant une borne de sortie couplée à la seconde borne d'entrée dudit autre moyen de combinaison de signaux (70), et ayant une borne d'entrée couplée à la borne de sortie dudit second moyen de combinaison de signaux (40).

13. Le système selon la revendication 12, caractérisé en ce que le détecteur de mouvement précité (60) est configuré pour appliquer les signaux de commande correspondant aux facteurs de multiplication



comportant 1 au circuit de multiplication et à l'autre circuit de multiplication lorsque du mouvement est détecté et K_2 et $K_2/2$ au circuit de multiplication et à l'autre circuit de multiplication respectivement lorsqu'aucun mouvement n'est détecté, et où la grandeur de K_2 est une valeur inférieure à un.

- 5 14. Le système selon la revendication 13, caractérisé en ce que le détecteur de mouvement précité est configuré pour appliquer les signaux de commande correspondant aux facteurs de multiplication de $1/(2-K_2)$ et $1/2$ au circuit de multiplication précité et à l'autre circuit de multiplication précité respectivement pendant la première image d'absence de mouvement.

10

15

20

25

30

35

40

45

50

55

60

65

