Description

The present invention relates generally to video signal processing apparatus and particularly to apparatus for processing the color difference signal components of composite television signals.

NTSC composite television signals include three component signals, luminance, chrominance and sound. The luminance signal amplitude modulates a picture carrier signal to produce an upper sideband that is approximately 4 MHz wide and a lower sideband that is approximately 750 KHz wide. The chrominance signal amplitude and phase modulates a suppressed chrominance subcarrier signal. This subcarrier signal is at a frequency 3.58 MHz greater than the picture carrier and so, is within the frequency spectrum of the upper luminance sideband. The chrominance signal consists of two quadrature phase related components, the I and Q color difference signals. The Q component of the modulated chrominance subcarrier comprises two sidebands having equally wide frequency spectra (e.g. 500 KHz). The component of the modulated subcarrier also consists of two sidebands. However, these sidebands are asymmetrical; their frequency spectra have different widths (e.g. 500 KHz and 1.2 MHz). Consequently, the demodulated I and Q color difference signals may have different bandwidths. The sound signal frequency modulates a subcarrier signal that has a frequency 4.5 MHz greater than the picture carrier, and so is outside the frequency spectra of the modulated luminance and chrominance signals.

The close relationship among these modulated component signals makes their demodulation difficult. Two significant problems are the elimination of interference in the luminance signal resulting from the beat between the sound and chrominance subcarriers and the recovery of I color difference signals over their full 1.2 MHz frequency spectrum.

In the NTSC system, the difference between the frequencies of the chrominance and sound carriers is 920 KHz. The beat of these two frequencies is the baseband demodulated composite video signal produces interference in the luminance signal that appears as a fine herringbone pattern in the reproduced image. To minimize the magnitude of this interference, it is desirable to attenuate the modulated sound subcarrier prior to video amplification. This subcarrier is most commonly attenuated by using an intermediate frequency (IF) amplifier with a frequency characteristic having the sound subcarrier frequency in its roll-off region or in its stop band. This filter is usually supplemented by band rejection or trap filters, tuned to the sound carrier frequency, in the video signal processing circuitry.

This method of attenuation may cause problems if it affects the modulated chrominance signal. When the IF amplifier has a frequency characteristic that places part of the modulated chrominance signal in its pass band and part in the roll-off region, it induces quadrature distortion between the two color difference signal components of the modulated chrominance signal. This distortion results from analogous frequency components of the two sidebands of each of the color difference signals having different amplitude values. A bandpass filter in the chrominance processing circuitry which attenuates the sidebands that were passed by the IF amplifier, so their frequency spectra match the ones that were rolled off, will remove most of the quadrature distortion components. However, this type of filter attenuates the high frequency chrominance components, making it difficult to recover the full I color difference signal.

An IF amplifier that has a sharp roll-off in its frequency characteristic so that it passes the full chrominance signal but stops the audio carrier would not produce quadrature distortion in the chrominance signal. However, it is expensive to design and produce a filter of this type which does not cause undesirable phase shifting, and so color hue errors, in the chrominance signal components.

Even if the chrominance components of a composite television signal are recovered in their entirety and without quadrature distortion or hue errors, it is difficult to recover I color difference signals that have a uniform range of amplitude values over the full frequency spectrum of the I signal. Because of the asymmetrical sideband modulation of the chrominance subcarrier by the I signal, the demodulated high frequency components (from 500 KHz to 1.2 MHz) have amplitude ranges only half as large as those of the low frequency components (from 0 Hz to 500 KHz). To obtain I signals having the same range of amplitude values for both the low and high frequency components, the demodulator must either be preceded by a filter which modifies the frequency spectrum of the modulated signal to reject the narrower sideband or followed by a filter to equalize the response of the demodulated signal over the 1.2 MHz frequency spectrum. Both of these techniques require extra filtration and so, add to the cost of the television receiver.

In color television receivers employing digital video signal processing techniques, one can conveniently obtain separated chrominance signal components appearing in a sampled data format and occuring in a sequence of alternating first and second color difference signal samples.

Pursuant to the principles of the present invention as set forth in the claims, a relatively simple arrangement of cascaded delay stages and sample combining means may be employed to process chrominance signal components of the aforesaid format in a manner serving to substantially eliminate distortion components resulting from quadrature distortion. The use of cascaded delay stages and sample combining means for combining samples taken from respective ones of the delay stages for such purposes as filtering for example, see GB—A—2110047. For the purposes of the present invention, the cascaded delay elements, include several initial, intermediate, and final stages, with the initial and final stages both providing samples representative of one of said color difference signals when the intermediate stage provides samples representative of the other one of said color difference signals. The sample combining means serves to develop samples proportional to the difference in magnitude between the samples from

said initial and final stages, and to combine said developed samples and the samples from the intermediate stage in a manner substantially cancelling any quadrature distortion components included in the samples from the intermediate stage.

An illustrative use of the above-described invention is in a color television receiver attaining attenuation of the accompanying sound carrier at intermediate frequencies through use of an IF filter of the previously described type having a roll-off region encompassing a portion of the chrominance signal band. In such a use, though quadrature distortion is introduced by the IF filter, its effects are readily eliminated by the color-difference signal processing system embodying the present invention.

In accordance with a specific embodiment of the present invention, where the alternate color-difference signal samples are representative of the I and Q color difference signal components of an NTSC signal, full utilization of the (wider band) I signal is facilitated by an arrangement wherein the signals supplied to the cascaded delay elements are confined in frequency to the band of frequencies shared by the I and Q color-difference signals by a suitable low pass filter, wherein a demultiplexing means responsive to the output of the signal combining means serves to separate the I samples from the Q samples, and wherein further signal combining means serve to combine said separated samples with samples derived from a high pass filter and representative of frequency components of said I color difference signal lying outside said shared band.

In the accompanying drawings:

Figure 1 is a block diagram of a color difference signal processing system in accordance with the present invention.

Figure 2 is a graph of amplitude versus frequency which illustrates the frequency characteristic associated with the IF amplifier in the system of Figure 1.

Figures 3, 4A and 4B are graphs of amplitude versus frequency useful in explaining the operation of the system shown in Figure 1.

The following terminology is adopted to aid explanation of the present invention. The frequency characteristic of a filter has three parts: the pass band, the transition band and the stop band. The pass band is the band of frequencies passed by the filter with little or no attenuation. The stop band or bands are the ranges of frequencies that are maximally attenuated by the filter. Between the pass band and a stop band is a band of frequencies having levels of attenuation that vary with variation in frequency; this is the roll-off region or transition band of the filter. Viewing the graph in Figure 2 as a frequency characteristic, the portions of the curve to the left of point A and to the right of point D are the stop bands. The portion between points B and C is the pass band. Accordingly, the portions between points A and B and between points C and D are the transition bands or roll-off regions of the characteristic.

The transition band of the frequency characteristic between points A and B is oddly symmetric about the frequency of the suppressed chrominance subcarrier. The results of this odd symmetry, as stated above, is that the sum of the amplitude values for frequencies equally displaced above and below the point of symmetry equals the amplitude value for frequencies in the pass band. For example, if the amplitude value on the response curve shown in Figure 2 for 42 42 MHz (250 KHz greater than the subcarrier frequency) is X, then the amplitude for 41.92 MHz (250 KHz less than the subcarrier frequency) is 1-X.

The operational details of the present invention are most easily explained in the context of a mathematical model. In the equations that follow C(t) represents the chrominance signal. The low frequency double-sideband modulating I and Q color difference signal components are represented as I_L and Q_L respectively, and the high frequency single-sideband modulating I signal component is represented as $I_H(t)$. As only one sideband exists for these high frequency I signal components, quadrature distortion arms, in the form of Hilbert transformed high frequency I signal components ($\hat{I}_H(t)$) contaminate the modulated Q signal at frequencies outside the frequency spectrum of the Q signal. The equations below use the first and second derivative of various ones of the signals listed above. The first derivative of the low frequency I signal component is designated, for example, $I_L'(t)$, and the second derivative is designated $I_L''(t)$.

The suppressed carrier modulated by these signals can be represented by cos $\omega_{sc}t$. The textbook equation:

$$C_I(t) = (I_L(t) + \tfrac{1}{2}I_H(t)) \cos \omega_{sc}t + (Q_L(t) + \tfrac{1}{2}\hat{I}_H(t)) \sin \omega_{sc}t \quad (1)$$

describes the chrominance component of a composite television signal. If the signal in equation 1 is applied to a filter which has a linear transition band that is oddly symmetric about the chrominance subcarrier frequency and coextensive with the frequency spectrum of the double-sideband modulated components of the color difference signals, chrominance signals, $C_I(t)$, are obtained. The amplitude of the low frequency components of each of the color difference signals that make up these chrominance signals is reduced by one-half by the action of this filter. Additionally, each of the two color difference signal components of $C_I(t)$ contains quadrature distortion components proportional to the first derivative of the

low frequency components of the other color difference signal component. The equation that describes this signal is known in the art as:

$$C_I(t) = \tfrac{1}{2}(I_L(t) + (1/\omega_m)Q_L'(t) + I_H(t)) \cos \omega_{sc}t + \tfrac{1}{2}(Q_L(t) - ((1/w_m)I_L'(t) - \hat{I}_H(t))) \sin \omega_{sc}t \quad (2)$$

In this equation, ω_m is 2 π times a frequency (f_m) equal to one-half of the width of the transition band of the filter, or 2 π (500 KHz). Applying the signal in equation 2 to a low pass filter which removes the high frequency I signal components, and demodulating the sin and cos terms separately yields low frequency I and Q color difference signals each containing a quadrature distortion component proportional to the first derivative of the other. The equations that describe these two components, I_{DL} and Q_{DL}, are:

$$I_{DL}(t) = \tfrac{1}{2}(I_L(t) + (1/\omega_m)Q_L'(t)) \quad (3)$$

$$Q_{DL}(t) = \tfrac{1}{2}(Q_L(t) - (1/\omega_m)I_L'(t)) \quad (4)$$

The quadrature distortion in each of the color difference signals can be approximated by the scaled derivative of the other color difference signal. When the signal described by equation 3 is passed through a differentiator, scaled by a factor of $1/\omega_m$ and added to the signal described by equation 4, a resultant Q color difference signal, Q_R, is obtained that is described by the equation:

$$Q_R(t) = \tfrac{1}{2}(Q_L(t) + (1/\omega_m^2)Q_L''(t)) \quad (5)$$

Similarly, when the signal described by equation 4 is passed through a differentiator, scaled by a factor of $1/\omega_m$ and subtracted from the signal described by equation 3, the resultant I color difference signal, I_R, is described by the equation:

$$I_R(t) = \tfrac{1}{2}(I_L(t) + (1/\omega_m^2)I_L''(t)) \quad (6)$$

The equations 5 and 6 contain no quadrature distortion components and describe the same signal as would be obtained by passing the low frequency I and Q color difference signals through a low pass filter having a characteristic, H(ω), described by the equation:

$$H(\omega) = \tfrac{1}{2}(1 - (\omega/\omega_m)^2) \quad (7)$$

Peaking filters can be inserted in the system to process these two signals to compensate for the low pass filter roll-off, yielding signals that are good approximation of the low frequency components of the original modulating I and Q color difference signals.

It is noted that the amplitude of each of the derived color difference signals is one-half the level of the original modulating signal. This reduction in amplitude simplifies the recovery of a wide bandwidth I signal having a relatively uniform range of amplitude values over its frequency spectrum. By placing a high pass filter in parallel with the low pass filter described above, the high frequency I signal components can be extracted from the signal represented by equation 2. When these components are added to the derived low frequency I signal components, a composite I color difference signal is obtained having a nearly uniform range of amplitude values over its frequency spectrum. The frequencies close to 500 KHz have different ranges of amplitude values since the peaking filter cannot completely compensate for the roll-off in this range of frequencies of the signal represented by equation 6.

The mathematical model described above is closely approximated by the apparatus described below. This embodiment of the invention is in the context of a digital television receiver.

In the drawings, broad arrows represent busses for multiple-bit parallel digital signals. Line arrows represent connections carrying analog signals or single-bit digital signals.

In Figure 1, radio frequency (RF) composite television signals are received by tuner 10 through antenna 8. Tuner 10 converts the RF signals to intermediate frequency (IF) signals which are applied to IF amplifier 12 including a suitable IF filter. There are two paths through IF amplifier 12, one for sound and one for video. The modulated intermediate frequency sound signals are provided at terminal MS. These signals are applied to sound signal processor 14 where they may be demodulated and amplified to produce sound signals at terminal S for application to, for example, a loudspeaker (not shown).

The video intermediate frequency signals provided by IF amplifier 12 at terminal MV have a frequency spectrum similar to that shown in Figure 2. The part of the frequency spectrum incorporating the double-sideband modulated portions of the I and Q color difference signals is between points A and B. This part exhibits, for example, an approximately linear roll-off that is oddly symmetric about the frequency of the suppressed chrominance subcarrier signal. The low frequency transition band in the frequency characteristic of the IF amplifier produces this linear, symmetric roll-off and, as set forth above, induces quadrature distortion between the two color difference signals.

The video IF signals at terminal MV are applied to video detector 16 where they are demodulated into

baseband video signals. The signals provided by detector 16 are sampled at a rate equal to four times the chrominance subcarrier frequency ($4f_{sc}$) and converted into digital values by analog to digital (A/D) converter 18. These digital samples are applied to luminance-chrominance separation filter 20, the outputs of which are samples representing the luminance components of the composite video signal on bus Y and samples representing the chrominance components on bus C.

The luminance samples are applied to luminance processor 22 where they may be filtered for noise reduction and peaked to compensate for attenuation of high frequency components. These processed luminance samples are applied to digital matrix 24 where they are combined with processed color difference samples to produce samples on busses R, G and B, representing the three primary color signals red, green and blue respectively.

Chrominance samples on bus C are applied to complex demodulator 26. The samples on bus C are a sequence of alternating I and Q samples representing, respectively, the I and Q color difference signals. The sequence may be represented as, . . . +I, +Q, −I, −Q, +I . . . where the signs of the samples represent their sampling phase, not their polarity. Complex demodulator 26 reverses the polarity of the negative phase samples (i.e. −I and −Q) and passes the positive phase samples unchanged. The samples provided by complex demodulator 26, therefore, are alternating I and Q samples wherein all of the I samples appear to have been sampled at the same phase value as do all of the Q samples.

These samples are applied to low pass filter 28. Filter 28 may be a finite impulse response (FIR) filter which provides alternating low pass filtered I and Q samples. The samples from filter 28 are applied to the signal processing network 30 which removes a substantial portion of the quadrature distortion components induced by the IF amplifier 12. Network 30 includes three stage shift register 32, multipliers 34 and 36, coefficient sources 38 and 40, multiplexers 42 and 44, frequency divider 46 and summer 48. Samples from filter 28 are applied to shift register 32 at the system clock rate of four times the chrominance subcarrier frequency ($4f_{sc}$). At any given time, the sample in the center stage of the shift register represents one of the color difference signals and the samples in the two outside stages represent the other color difference signal. Assume that the sample in the center stage is an I sample and the samples in the outer stages are Q samples. The Q sample in the first stage of register 32 is applied to multiplier 34 and the Q sample in the third stage is applied to multiplier 36. Multiplier 34 weights the applied Q sample by a coefficient value supplied by multiplexer 42. Similarly, multiplier 36 weights the Q sample from the third stage by the coefficient value from multiplexer 44.

The scaled Q samples from multipliers 34 and 36 and the I sample from the second stage of shift register 32 are all applied to summer 48. Summer 48 produces samples I_R defined by the equation:

$$I_R = I_n - A(Q_n - Q_{n+1}) \tag{8}$$

where Q_{n+1} and Q_n are the samples in the third and first stages of the shift register 32 respectively representing successive sample values of the signal described by equation 4, and A is the magnitude of the weighting coefficients. In the present embodiment, A has a value approximating $f_{sc}/(nfm)$. Since the difference between successive Q samples approximates the first derivative of the Q color difference signal the samples I_R approximate the signal described by equation 6 when equation 3 is substituted for I_n.

During alternate states, when consecutive I samples, I_{n+1} and I_n, are in the first and third stages respectively of the shift register 32 and a Q sample, Q_n, is in the second stage, divider 46 controls multiplexers 42 and 44 so that the coefficient +A is applied to multiplier 34 and the coefficient −A is applied to multiplier 36. The scaled I samples and the Q samples are all applied to summer 48 which produces samples, Q_R, defined by the equation:

$$Q_R = Q_n + A(I_n - I_{n+1})$$

This equation approximates the signal described by equation 5 above when equation 4 is substituted for Q_n.

The coefficient values applied to multiplexers 34 and 36 alternate between +A and −A. For Q samples in the first and third stages of shift register 32, −A is applied to multiplier 34 and +A to multiplier 36. When I samples are in the first and third stages +A is applied to multiplier 34 and −A to multiplier 36. This change in sign of the coefficients is to account for the difference in sign of the last terms of equations 3 and 4.

The coefficients are provided by sources 38 and 40 and applied to multiplexers 42 and 44. Multiplexers 42 and 44 are switched under the control of circuit 46. Circuit 46 is a divide by two frequency divider to which the $4f_{sc}$ system clock is applied. Complementary signals, Q and $\overline{Q}$, occurring at a $2f_{sc}$ rate are produced by circuit 46 and applied to the control inputs of multiplexers 42 and 44.

The alternating I and Q samples provided by summer 48 represent I and Q signals having the frequency spectrum exhibited by curve 100 of Figure 3. These samples are applied to peaking filter 50 which has a frequency characteristic similar to the one shown by curve 102 of Figure 3. Filter 50 compensates for the high frequency roll-off of the frequency spectrum shown in curve 100 and produces I and Q samples having frequency spectra similar to that shown in Figure 4A.

The interleaved I and Q samples from filter 50 are separated into a sequence of I samples and a sequence of Q samples by demultiplexer 52. Demultiplexer 52 is clocked by circuit 46 at one-half of the

sample rate to divide alternate samples between its two output ports. I samples occurring at a $2f_{sc}$ rate are provided at one output port and Q samples at the same rate are provided at the other output port.

The I samples are applied to the first input of adder 56 to be combined with samples representing the high frequency components of the I signal. These high frequency component samples are generated by subtracter 58. All-pass demodulated output signals from complex demodulator 26 are applied through delay element 57, to the minuend input and the corresponding low pass filtered output samples from filter 28 are applied to the subtrahend input of subtracter 58. The samples provided by subtracter 58 are high frequency components of the I samples interleaved with high frequency quadrature distortion components, $\hat{I}_H$, from the Q samples.

These samples are applied to decimating element 60 which removes every other sample representing the high frequency quadrature distortion components, $\hat{I}_H$. The eliminated samples are replaced by the immediately preceding high frequency I samples. Decimating element 60, therefore, provides samples at its output which represent the high frequency components of the I signal at an effective $2f_{sc}$ rate. These samples are applied to the second input of adder 56 which combines them with the low frequency component I samples from demultiplexer 52. Decimating element 60 in its simplest form may be, for example, a latch clocked at one-half of the system clock rate.

The samples provided by adder 56 represent full bandwidth I color difference signals having a frequency spectrum similar to the one shown in Figure 4B. As explained above in reference to the mathematical model, the dip in the amplitude range of the frequency spectrum close to 500 KHz occurs because the peaking filter 50 is unable to completely compensate for the roll-off in the low frequency I signal caused by the combination of filters 12 and 28.

The I signal from adder 56 is applied to I signal processor 62 via bus I where it may, for example, be filtered for noise reduction and subject to autoflesh correction. Output signals from processor 62 are applied to one of the color difference signal input ports of matrix 24.

Q color difference signals from demultiplexer 52 are applied to Q signal processor 64 where they may be filtered to reduce their noise components and processed for autoflesh correction. The output signals of processor 64 are applied to the other color difference signal input of digital matrix 24 to be combined with the luminance and I signals, as described above, to produce red, green and blue primary color samples.

The embodiment described above is particularly advantageous because it operates on interleaved I and Q samples. For example, signal processing network 30 differentiates both the I and Q signals, subtracts the differentiated I signal from the Q signal and subtracts the differentiated Q signal from the I signal using a simple three tap FIR filter.

The signal processing paths for the luminance, I and Q samples may have different processing delays. It may, therefore, be necessary to include compensating delays in as many as two of these three signal processing paths.

The frequency characteristic described above for IF amplifier 12 is not the only one contemplated for use with the present invention. For example, a filter having a transition band in its frequency characteristic that is nonlinear but still symmetric about the chrominance subcarrier may be used. With such a filter it would be desirable to use a signal processing network 30 that removes the quadrature distortion components induced by the nonlinear transition band.

It is further contemplated that the system described above can be used in processing the U and V color difference signals as a part of a phase alternate line (PAL) television signal processing system. PAL television signals have quadrature modulated color difference signals and a sound signal that can combine to produce interference in the luminance signal. Although quadrature distortion is less visible in the PAL system it is believed that a PAL signal processing system would be improved by incorporating the invention described herein.

Claims

1. A video signal processing system for processing signals having chrominance signal components including first and second color difference signals wherein said first color difference signal includes quadrature distortion signal components related to said second color difference signal and said second color difference signal includes quadrature distortion signal components related to said first color difference signal, said chrominance signal components being available in sampled data format and occurring in a sequence of alternating first and second color difference signal samples; said video signal processing system including a shift register (32) comprising cascaded delay stages responsive to said chrominance signal components in said sampled data format, and sample combining means (48) responsive to samples derived from respective ones of said cascaded delay stages; characterised in that the samples to which said sample combining means is responsive consist of samples derived from three directly successive ones of said delay stages, whereby samples derived from the initial and final stages of said three directly successive stages are representative of said first color difference signal when the sample derived from the intermediate stage of said three directly successive stages is representative of said second color difference signals, and are representative of said second color difference signal when the sample derived from said intermediate stage is representative of said first color difference signal; and further in that the sample combining means (48) combines samples from said intermediate stage with samples

sample rate to divide alternate samples between its two output ports. I samples occurring at a $2f_{sc}$ rate are provided at one output port and Q samples at the same rate are provided at the other output port.

The I samples are applied to the first input of adder 56 to be combined with samples representing the high frequency components of the I signal. These high frequency component samples are generated by subtracter 58. All-pass demodulated output signals from complex demodulator 26 are applied through delay element 57, to the minuend input and the corresponding low pass filtered output samples from filter 28 are applied to the subtrahend input of subtracter 58. The samples provided by subtracter 58 are high frequency components of the I samples interleaved with high frequency quadrature distortion components, $\hat{I}_H$, from the Q samples.

These samples are applied to decimating element 60 which removes every other sample representing the high frequency quadrature distortion components, $\hat{I}_H$. The eliminated samples are replaced by the immediately preceding high frequency I samples. Decimating element 60, therefore, provides samples at its output which represent the high frequency components of the I signal at an effective $2f_{sc}$ rate. These samples are applied to the second input of adder 56 which combines them with the low frequency component I samples from demultiplexer 52. Decimating element 60 in its simplest form may be, for example, a latch clocked at one-half of the system clock rate.

The samples provided by adder 56 represent full bandwidth I color difference signals having a frequency spectrum similar to the one shown in Figure 4B. As explained above in reference to the mathematical model, the dip in the amplitude range of the frequency spectrum close to 500 KHz occurs because the peaking filter 50 is unable to completely compensate for the roll-off in the low frequency I signal caused by the combination of filters 12 and 28.

The I signal from adder 56 is applied to I signal processor 62 via bus I where it may, for example, be filtered for noise reduction and subject to autoflesh correction. Output signals from processor 62 are applied to one of the color difference signal input ports of matrix 24.

Q color difference signals from demultiplexer 52 are applied to Q signal processor 64 where they may be filtered to reduce their noise components and processed for autoflesh correction. The output signals of processor 64 are applied to the other color difference signal input of digital matrix 24 to be combined with the luminance and I signals, as described above, to produce red, green and blue primary color samples.

The embodiment described above is particularly advantageous because it operates on interleaved I and Q samples. For example, signal processing network 30 differentiates both the I and Q signals, subtracts the differentiated I signal from the Q signal and subtracts the differentiated Q signal from the I signal using a simple three tap FIR filter.

The signal processing paths for the luminance, I and Q samples may have different processing delays. It may, therefore, be necessary to include compensating delays in as many as two of these three signal processing paths.

The frequency characteristic described above for IF amplifier 12 is not the only one contemplated for use with the present invention. For example, a filter having a transition band in its frequency characteristic that is nonlinear but still symmetric about the chrominance subcarrier may be used. With such a filter it would be desirable to use a signal processing network 30 that removes the quadrature distortion components induced by the nonlinear transition band.

It is further contemplated that the system described above can be used in processing the U and V color difference signals as a part of a phase alternate line (PAL) television signal processing system. PAL television signals have quadrature modulated color difference signals and a sound signal that can combine to produce interference in the luminance signal. Although quadrature distortion is less visible in the PAL system it is believed that a PAL signal processing system would be improved by incorporating the invention described herein.

Claims

1. A video signal processing system for processing signals having chrominance signal components including first and second color difference signals wherein said first color difference signal includes quadrature distortion signal components related to said second color difference signal and said second color difference signal includes quadrature distortion signal components related to said first color difference signal, said chrominance signal components being available in sampled data format and occurring in a sequence of alternating first and second color difference signal samples; said video signal processing system including a shift register (32) comprising cascaded delay stages responsive to said chrominance signal components in said sampled data format, and sample combining means (48) responsive to samples derived from respective ones of said cascaded delay stages; characterised in that the samples to which said sample combining means is responsive consist of samples derived from three directly successive ones of said delay stages, whereby samples derived from the initial and final stages of said three directly successive stages are representative of said first color difference signal when the sample derived from the intermediate stage of said three directly successive stages is representative of said second color difference signals, and are representative of said second color difference signal when the sample derived from said intermediate stage is representative of said first color difference signal; and further in that the sample combining means (48) combines samples from said intermediate stage with samples

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proportional to the difference in magnitude between samples derived from said initial and final stages in a manner to substantially cancel the quadrature distortion signal components included in the samples from said intermediate stage.

2. A video signal processing system in accordance with claim 1, also including a first multiplier (34), interposed between said initial stage and said sample combining means (48); and a second multiplier (36), interposed between said final stage and said sample combining means; wherein said first multiplier (34) subjects the samples delivered from said initial stage to said sample combining means to multiplication by a predetermined positive coefficient during alternate sampling intervals and by a predetermined negative coefficient during the intervening sampling intervals; and said second multiplier (36) subjects the samples delivered from said final stage to said sample combining means to multiplication by said predetermined negative coefficient during said alternate sampling intervals and by said predetermined positive coefficient during said intervening sampling intervals.

3. A video signal processing system in accordance with claim 2, also including a peaking filter (50) responsive to the output of said sample combining means (48) for increasing the amplitude of the high frequency components relative to the low frequency components of said output of said signal combining means, and demultiplexing means (52) responsive to the output of said peaking filter (50) for separating the samples representing said first color difference signal from the samples representing said second color difference signal and for providing said separated samples at respective output ports.

4. A video signal processing system in accordance with claim 3 wherein the bandwidth of said first color difference signal (I) exceeds the bandwidth of said second color difference signal (Q), and wherein chrominance signal components (C) supplied to said cascaded delay elements are confined in frequency (28) to the band of frequencies shared by said first and second color difference signals; said system also including signal combining means (56), coupled to the output port of said demultiplexing means (52) at which samples representing said first color difference signal are provided, for combining said provided samples with samples derived (57, 58, 60) as representative of components of said first color difference signal having frequencies lying outside said shared band.

Patentansprüche

1. Videosignalverarbeitungseinrichtung zum Verarbeiten von Signalen, welche Farbartsignalkomponenten einschließlich eines ersten und eines zweiten Farbdifferenzsignales enthalten, wobei das erste Farbdifferenzsignal um 90 Grad in der Phase verschobene Störsignalkomponenten, die mit dem zweiten Farbdifferenzsignal in Beziehung stehen, und das zweite Farbdifferenzsignal un 90 Grad in der Phase verschobene Störsignalkomponenten, die mit dem ersten Farbdifferenzsignal in Beziehung stehen, enthalten, die Farbartsignalkomponenten im Abtastdatenformat zur Verfügung stehen und in einer Folge von alternierenden ersten und zweiten Farbdifferenzsignal-Abtastwerten auftreten; mit einem Schieberegister (32), welches in Kaskade geschaltete Verzögerungsstufen enthält, welche auf die Farbartsignalkomponenten in dem Abtastdatenformat ansprechen und einer Abtastwertkombinieranordnung (48), welche auf Abtastwerte anspricht, welche von entsprechenden der in Kaskade geschalteten Verzögerungsstufen gewonnen wurden, dadurch gekennzeichnet, daß die Abtastwerte, auf die die Abtastwertkombinieranordnung anspricht, aus Abtastwerten bestehen, die von drei direkt auf einanderfolgenden Verzögerungsstufen erhalten wurden, wobei die von der ersten und der letzten der drei direkt aufeinanderfolgenden Stufen erhaltenen Abtastwerte das erste Farbdifferenzsignal repräsentieren, wenn der von der mittleren der drei direkt aufeinanderfolgenden Stufen erhaltene Abtastwert für die zweiten Farbdifferenzsignale repräsentativ ist, und das zweite Farbdifferenzsignal repräsentieren, wenn der von der mittleren Stufe erhaltene Abtastwert für das erste Farbdifferenzsignal repräsentativ ist; und daß weiterhin die Abtastwerkombinieranordnung (48) Abtastwerte von der mittleren Stufe mit Abtastwerten, die der Differenz der Größen der von der ersten und der letzten Stufe erhaltenen Abtastwerte proportional sind, in einer Weise kombiniert, daß die in den Abtastwerten von der mittleren Stufe enthaltenen, um 90 Grad in der Phase verschobenen Störsignalkomponenten im wesentlichen aufgehoben werden.

2. Videosignalverarbeitungseinrichtung gemäß Anspruch 1, die außerdem einen ersten Multiplizierer (34), der zwischen die erste Stufe und die Abtastwertkombinieranordnung (48) geschaltet ist, und einen zweiten Multiplizierer (36), der zwischen die letzte Stufe und die Abtastwertkombinieranordnung geschaltet ist, enthält, wobei der erste Multiplizierer (34) die Abtastwerte, die von der ersten Stufe an die Abtastwertkombinieranordnung geliefert werden, einer Multiplikation mit einem vorgegebenen positiven Koeffizienten während alternierender Abtastintervalle und mit einem vorgegebenen negativen Koeffizienten während der dazwischenliegenden Abtastintervalle unterwirft und der zweite Multiplizierer (36) die Abtastwerte, die von der letzten Stufe an die Abtastwertkombinieranordnung geliefert werden, einer Multiplikation mit dem vorgegebenen negativen Koeffizienten während der alternierenden Abtastintervalle und mit dem vorgegebenen positiven Koeffizienten während der dazwischenliegenden Abtastintervalle unterwirft.

3. Videosignalverarbeitungseinrichtung gemäß Anspruch 2, welche außerdem ein Versteilerungsfilter (50), welches auf das Ausgangssignal der Abtastwertkombinieranordnung (48) anspricht, um die Amplitude der hochfrequenten Komponenten des Ausgangssignales der Signalkombinieranordnung

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relativ zu den niederfrequenten Komponenten zu erhöhen, und eine Demultiplexanordnung (52), welche auf das Ausgangssignal des Versteilerungsfilters (50) anspricht, um die Abtastwerte, die das erste Farbdifferenzsignal darstellen, von den Abtastwerten, die das zweite Farbdifferenzsignal darstellen, zu trennen und die getrennten Abtastwerte an entsprechenden Ausgangsanschlüssen zu liefern, enthält.

4. Videosignalverarbeitungseinrichtung nach Anspruch 3, dadurch gekennzeichnet, daß die Bandbreite des ersten Farbdifferenzsignals (I) die Bandbreite des zweiten Farbdifferenzsignals (Q) überschreitet die Farbartsignalkomponenten (C), die den in Kaskade geschalteten Verzögerungselementen zugeführt werden, in der Frequenz (28) auf das Frequenzband beschränkt sind, in das sich das erste und das zweite Farbdifferenzsignal teilen; daß die Einrichtung außerdem eine Signalkombinieranordnung (56) enthält, die mit dem Ausgangsanschluß der Demultiplexanordnung (52), an dem die das erste Farbdifferenzsignal darstellenden Abtastwerte geliefert werden, gekoppelt ist, um die gelieferten Abtastwerte mit Abtastwerten zu kombinieren, welche als repräsentativ für Komponenten des ersten Farbdifferenzsignales mit Frequenzen, die außerhalb des gemeinsamen Bandes liegen, gewonnen wurden (57, 58, 60).

Revendications

1. Un système de traitement de signaux vidéo pour traiter des signaux ayant des composantes d'un signal de chrominance comportant des premier et second signaux de différence de couleurs dans lesquels le premier signal de différence de couleurs comprend des composantes de signaux de distorsion en quadrature en rapport au second signal de différence de couleurs et le second signal de différence de couleurs comprend des composantes de signaux de distorsion en quadrature en rapport au premier signal de différence de couleurs, les composantes du signal de chrominance étant disponibles en un format de données échantillonnées et se produisant en une séquence de premier et second échantillons de signaux de différence de couleurs alternants; le système de traitement de signaux vidéo comprenant un registre à décalage (32) comprenant des étages à retard en cascade répondant auxdites composantes de signaux de chrominance dans ledit format de données échantillonnées, et un moyen de combinaison d'échantillons (48) répondant aux échantillons dérivés des étages respectifs des étages à retard en cascade; caractérisé en ce que les échantillons auxquels le moyen de combinaison d'échantillons répond consistent en échantillons dérivés des trois étages directement successifs des étages à retard, de la sorte des échantillons dérivés des étages initial et final des trois étages directement successifs sont représentatifs du premier signal de différence de couleurs lorsque l'échantillon dérivé de l'étage intermédiaire des trois étages directement successifs est représentatif du second signal de différence de couleurs, et sont représentatifs du second signal de différence de couleurs lorsque l'échantillon dérivé de l'étage intermédiaire est représentétif du premier signal de différence de couleurs; et en ce que de plus le moyen de combinaison d'échantillons (48) combine les échantillons de l'étage intermédiaire aux échantillons proportionnels à la différence en grandeur entre des échantillons dérivés des étages initial et final d'une manière à supprimer sensiblement les composantes de signaux de distorsion en quadrature incluses dans les échantillons dudit étage intermédiaire.

2. Un système de traitement de signaux vidéo selon la revendication 1, comprenant également un premier multiplicateur (34), interposé entre l'étage initial précité et le moyen de combinaison d'échantillons précité (48); et un second multiplicateur (36), interposé entre l'étage final précité et le moyen de combinaison d'échantillons; où le premier multiplicateur (34) soumet les échantillons produits de l'étage initial au moyen de combinaison d'échantillons à une multiplication par un coefficient positif prédéterminé pendant des intervalles d'échantillonnage alternés et par un coefficient négatif prédéterminé pendant les intervalles d'échantillonnage intervenants; et le second multiplicateur (36) soumet les échantillons produits de l'étage final au moyen de combinaison d'échantillons à une multiplication par le coefficient négatif prédéterminé pendant des intervalles d'échantillonnage alternés et par le coefficient positif prédéterminé pendant lesdits intervalles d'échantillonnage intervenants.

3. Un système de traitement de signaux vidéo selon la revendication 2, comprenant également un filtre d'écrêtage (50) répondant à la sortie du moyen de combinaison d'échantillons précité (48) pour augmenter l'amplitude des composantes de haute fréquence par rapport aux composantes de basse fréquence de la sortie du moyen de combinaison de signaux, et un moyen de démultiplexage (52) répondant à la sortie du filtre d'écrêtage (50) pour séparer les échantillons représentant le premier signal de différence de couleurs précité des échantillons représentant le second signal de différence de couleurs précité et pour produire les échantillons séparés aux bornes de sortie respectives.

4. Un système de traitement de signaux vidéo selon la revendication 3, où la largeur de bande du premier signal de différence de couleurs précité (I) dépasse la largeur de bande du second signal de différence de couleurs précité (Q), et où les composantes du signal de chrominance (C) appliquées aux éléments à retard précités en cascade sont confinées en fréquence (28) à la bande de fréquence partagée par les premier et second signaux de différence de couleurs; ledit système comprenant également un moyen de combinaison de signaux (56), couplé à la borne de sortie du moyen de démultiplexage précité (52) à laquelle les échantillons représentant le premier signal de différence de couleurs sont produits, pour combiner lesdits échantillons produits aux échantillons dérivés (57, 58, 60) comme représentatifs de composantes du premier signal de différence de couleurs ayant des fréquences s'étendant hors de la bande partagée.

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