Description

This invention relates to television apparatus with vertical detail enhancement. Illustratively the invention concerns television display apparatus for displaying the picture information of a television signal that was produced by an interlaced scanning process in a non-interlaced scanning format and reference is made to such apparatus hereinafter by way of example.

Television signals based on present day standards create visible artifacts on conventional television receivers and monitors. In broadcast systems such as the 525 line-per-frame, 30 frame-per-second 525/30 NTSC system or the 625/25 PAL system, artifacts occur because of the interlaced scanning process. This process divides the 525-line picture or frame of the NTSC standard into two successive 262½-line fields. The 262½ lines of one field are scanned in 1/60th of a second followed by scanning of an additional 262½ lines of another field with lines of the second field occupying the spaces between the lines of the first field. One subjective effect of this interlaced scan is to create in the presence of motion in the picture scene an apparent vertical line break-up motion of the lines of the raster known as "line crawl". The apparent drift is substantially more noticeable when viewing a wide-screen display at close range. Another well-known objectionable visible effect is interline flicker on line-to-line transitions that occurs because of the interlaced scanning format.

Recent interest in the development of high definition television systems (HDTV) has been directed towards techniques that are intended to enhance the subjective performance of present systems within the constraints of existing standards. One approach, a technique referred to as progressive scan, or non-interlaced scan, has been described in patent materials and literature. For example, all 525 scan lines (for 525 lines-per-field, 60 Hz) are scanned consecutively from the top of the display screen and downward to the bottom of the display screen during each vertical scanning interval of, for example, 1/60th of a second. Progressive scan results in the reduction of artifacts related to the interlaced scanning format, such as interline flicker and line crawl that exist in conventional two-to-one interlaced displays. The subjective effect is a more pleasing picture presentation to the viewer.

GB-A-2145603, DE-A-3431200, FR-A-2551292 and IT-A-22422A/84 correspond to U.S. Patent Application Serial No. 526,702, filed in USA August 26, 1983 entitled, PROGRESSIVE SCAN TELEVISION SYSTEM EMPLOYING VERTICAL DETAIL ENHANCEMENT, in the name of D.H.Pritchard and W.E. Sepp. These GB, DE, FR and IT applications have a priority date earlier than that of the present application but were published after the priority date of the present application. In the U.S. application of Pritchard et al (and the GB, DE, FR and IT applications) an apparatus for displaying the picture information of, for example, a baseband NTSC signal is disclosed. The television apparatus that is disclosed in the Pritchard et al application generates, during each horizontal video line time of the NTSC signal, a pair of luminance information containng signals. The picture information that is produced in one of the pair of signals, during each horizontal video line time of the NTSC signal, is displayed in a first scan line of the display and that of the other is displayed immediately afterward in the next adjacent scan line below the first scan line. In order to display the luminance information that is included in both signals during one horizontal scan line time of the NTSC signal, each one is speeded up, or compressed. Thus, in the television apparatus of Pritchard et al., picture information is displayed in a given pair of scan lines during the same period in which picture information, in the standard interlaced television receiver, is displayed in only one scan line.

Each signal of the pair of luminance signals is generated using a line comb filter. Because of the interpolation, or the averaging process, that occurs in the summation process of the line comb filter, some loss of vertical detail occurs. Such loss of vertical detail may be noticeable in the section of the display where picture vertical transitions occur. The Pritchard et al. application discloses an approach for reinserting vertical detail signal components to compensate for the loss that occurs as a result of the averaging process. There, the vertical detail is obtained from the subtraction process in a comb filter source and reinserted in a specific manner to enhance the subjective vertical sharpness and to produce a "clean" subjective picture.

The non-interlaced scanning format reduces interline flicker and line crawl type artifacts that arise from the interlaced scanning format in standard television displays. However, artifacts caused by the interlaced scanning process at the source of the interlaced signal, such as at the television camera, are not eliminated by the non-interlaced scanning format of the television receiver. Furthermore, when vertical detail enhancement process is employed in the television receiver, such as disclosed in the Pritchard et al. application, the visibility of such source related artifacts may even be increased. Such artifacts are caused at the source of the interlaced television signal by the aliasing components that are included in the interlaced NTSC signal. The aliasing components in the interlaced NTSC signal are generated as a consequence of the overlapping of the field-to-field sidebands gen-

erated by the sampling process that is inherent in producing interlaced signals at the camera.

Because of the interlaced scanning format that is used at the source, the frequency spectrum of the signal that is produced by the television camera includes integer multiples of the horizontal scanning frequency of illustratively 15734 Hz with sidebands, of illustratively multiples of 30 Hz, the vertical rate, above and below each multiple of the horizontal scanning frequency. In processing a still image at the camera, the sidebands produced include frequencies that are spaced from the horizontal scanning frequency by integer multiples of 30 Hz. Because of the shape of the scanning spot, which is typically gaussian or cosine, at the camera, these sidebands may include aliasing components. These aliasing components are visible when the vertical components of moving objects are displayed in the television receiver display, and also when differences in the scene content due to television camera vertical panning occur from one field time to the immediately following one. Such differences in the scene are generally referred to as motion in the picture scene.

GB-A-2114848 discloses a circuit for converting a "standard", e.g. NTSC, signal into a signal suitable for display by progressive scanning. The circuit produces line delayed and frame delayed signals. Chrominance separation is achieved using both line delayed and frame delayed signals. Similarly, line interpolation is achieved using line delayed and frame delayed signals. A movement detector detects movement in the picture represented by the standard signal. With no movement chrominance separation and line interpolation involves the frame delayed signals. With movement, chrominance separation and line interpolation involves the line delayed signals. This prior art has no means to form a second signal which contains enhanced picture detail.

According to the invention there is provided a television apparatus for processing a composite color video signal which represents picture information comprising: comb filter means for separating said video signal into a first luminance signal and a chrominance signal; low pass filter means to which the chrominance signal is supplied for producing a picture detail signal which is representative of vertical picture detail missing in the first luminance signal; means for producing a signal which is indicative of motion in the picture; and means for combining said picture detail signal with said first luminance signal in accordance with said motion indicative signal, to form a second luminance signal containing enhanced vertical picture detail, the proportion of said picture detail signal in the second luminance signal being inversely related to the amount of motion in the picture as indicated by the motion indicative signal.

In an embodiment of the invention said motion indicative signal producing means includes a filter for extracting a portion of the frequency spectrum of said television signal that contains substantial spectral information only when motion occurs in the picture scene.

For a better understanding of the invention reference will now be made, by way of example, to the accompanying drawings in which:

FIGURE 1 illustrates a television apparatus of the invention which produces signals containing picture detail, in accordance with a motion indicative signal, for displaying the enhanced picture in non-interlaced scanning format;

FIGURES 2a and b illustrate the frequency spectrum of an NTSC signal for stationary and for non-stationary pictures, respectively;

FIGURE 3a illustrates a block diagram of a motion detector that generates the motion indicative signal;

FIGURES 3b and c are waveforms useful in explaining operation of the motion detector of FIGURE 3a;

FIGURE 4 illustrates two examples of the dependency between the gain factor K of one of the gain controlled devices used in the apparatus of FIGURE 1 and the motion indicative signal; and

FIGURE 5 illustrates an example of the transfer function A of a filter circuit of FIGURE 3, as a function of frequency.

Referring to FIGURE 1, an analog, composite, interlaced-scan color television NTSC signal 130 is applied to a terminal 11 from a source which is not shown. The source of the analog signal may be the demodulated output of the intermediate-frequency (IF) stage of a standard television receiver. It should be noted that the present invention will be described with reference to an NTSC composite, interlaced, color television signal, however, it should be obvious to one of skill in the art that other composite, or component, interlaced color television systems, such as PAL, fall within the scope of the invention described herein.

NTSC signal 130 is applied to a separator 15 which, illustratively, may be a two-terminal transversal filter having a 1-H delay 17, also known as a comb filter. A 1-H delay is equal to the time required to scan a horizontal line in an NTSC signal, e.g., 63.5μs. In separator 15 the 1-H delayed signal is combined in an adder 19 with NTSC signal 130 to form an interpolated signal Yi which is combed. Signal Yi represents an estimated signal between successive video lines. Signal Yl is the luminance-representative component of NTSC signal 130 having a frequency spectrum with signal energy concentrated in the vicinity of integer multiples of the

line rate, (i.e., 15 734 HZ) and nulls of signal energy in the vicinity of odd integer multiples of one-half of the line rate.

Similarly, delayed and undelayed lines are applied to a subtractor 18 which provides a combed chrominance signal Ci representing a portion of the luminance information and the chrominance information having a frequency spectrum with signal energy concentrated in the vicinity of odd integer multiples of one-half of the line rate (i.e., 15 734 Hz) and nulls of signal energy in the vicinity of integer multiples of the line rate. Chrominance signal Ci from subtractor 18 is bandpass filtered in a bandpass filter 25 to provide the combed modulated chrominance information to a demodulator 27. Demodulator 27 of conventional design provides the demodulated I and Q signals to speed-up processors 19 and 21, respectively.

Speed-up processors 119 and 21 produce time-compressed I and Q signals compressed at a multiple (e.g., two-times) of the input rate. For each horizontal video line of NTSC signal 130, speed up processor 119, for example, generates two video lines of an I_{2H} signal. Each of the two video lines of I_{2H} signal contains the same I information as in the corresponding uncompressed video line of the I signal. The I information in each of the two video lines of I_{2H} signal is speeded up to occupy 1/2 the time it occupies in the corresponding portion of the I signal. Speed up processor 119 generates, in a similar manner, a Q_{2H} signal from the Q signal. Speed-up processors 119 and 21 may be implemented as described in British Patent Application 2145602 (corresponding to U.S. Patent Application Serial No. 526,701, entitled, PROGRESSIVE SCAN SPEED UP PROCESSOR, filed August 26 1983, in the name of W.E. Sepp) the disclosure of which is herein incorporated by reference. The twice rate I_{2H} and Q_{2H} signals are coupled to an I,Q,Y matrix 43 for generating R, G and B signals, as discussed later on.

Luminance signal Yi is coupled to an input terminal 39a of a subtractor 39 and to an input terminal 33a of an adder 33. Chrominance signal Ci is coupled through a low pass filter 36, having a cutoff frequency of illustratively 1.5 MHz to form a vertical detail enhancement signal Yd at a terminal 23a. As explained below, signal Yd reinserts the vertical details in luminance signal Yi that were reduced in the combining process conducted in adder 19. Signal Yd is representative of line to line differential picture detail in the vertical direction.

Signal Yd is coupled through a gain controlled device 35 that is described later on, to the other input. terminal of adder 33. Adder 33 sums the signals at its respective input terminals to produce a Y_b signal that provides luminance information, as described later on. Likewise, vertical detail signal Yd is coupled through a gain controlled device 41, illustratively similar to gain controlled device 35, to the other input terminal of subtractor 39 where it is subtracted from luminance signal Yi. The result of the subtraction in subtractor 39 is a Y_a signal that also provides luminance information, as described later on.

Assume that the gain factor K of device 35 and device 41, respectively, is equal to 1. During each active video line time of NTSC signal 130, Y_a signal contains substantially all the luminance vertical details, up to the cutoff frequency of filter 36, of the portion of NTSC signal 130 that was coupled to terminal 11 during the immediately preceding active video line time of NTSC signal 130. Simultaneously, Y_b signal contains substantially all the luminance vertical details, up to the cutoff frequency of filter 36, of a portion of NTSC signal that was coupled to terminal 11 during the current active video line time of NTSC signal 130.

Y_a signal and Y_b signal are coupled to input terminals 23a and 23b, respectively, of a speed-up processor 23 that operates similarly to speed-up processor 19 or 21. In general, speed-up block 23, for example, may include four delay lines, each providing one horizontal line time delay, which are clocked-in at the four-times the color subcarrier rate (4sc) and read out by a commutation process at eight times the subcarrier rate (8sc). Thus, the output from speed-up block 23 is continuous video at two-times the horizontal line frequency producing a twice rate Y_{2H} signal.

During each horizontal video line time of 63.5 microseconds of NTSC signal 130, a video line of time compressed signal Y_a alternates with a video line of time compressed signal Y_b to provide luminance information for display in a pair of immediately consecutive non-interlaced scan lines, respectively. During each 63.5 microsecond, signal Y_{2H} includes two signal portions that contain the luminance information of Y_a and Y_b signals, respectively, in two consecutive time slots, each of 63.5/2 ~ 31.7 microseconds duration.

In each 63.5 microseconds of the horizontal video line time of NTSC signal 130, signal I_{2H}, that is the I signal speeded up in speed-up processor 119, includes two signal portions that provide I picture information for display in a pair of immediately consecutive non-interlaced scan lines, respectively. Simultaneously, signal Q_{2H}, that is the Q signal speeded up in speed-up processor 21, includes two signal portions that provide Q picture information for display in the pair of immediately consecutive scan lines, respectively. Signal Q_{2H} is combined in an I,Q,Y matrix 43 with signals I_{2H} and Y_{2H} on a non-interlaced, line-by-line basis, in a known manner, to form time-compressed R, G and B signals. The information contained in the time-

compressed R,G,B signals is displayed on the screen of display 51 by means of, for example, a progressively scanned raster display.

As disclosed in the Pritchard et al. application GB-A-2145603, the disclosure of which is herein incorporated by reference, the gain factor K of gain controlled devices 41 and 35, respectively, may be such that vertical peaking is produced in Y_a signal and in Y_b signal, respectively. It should be understood that the gain factor K of gain controlled device 41 may be different from that of gain controlled device 35. If K is greater than 1 in device 41 or 35, transitions in the vertical direction "overshoot" in comparison to the situation in which K=1. This enhancement of vertical details may provide for a more subjectively pleasing picture. As explained before, vertical detail enhancement is achieved by coupling vertical detail representative signal Yd through gain control devices 41 and 35, to the inputs of subtractor 39 and adder 33. In the illustrative embodiment of the invention of Figure 1, that vertical detail enhancement is reduced in the presence of motion as is explained in more detail hereinafter.

Vertical detail representative signal Yd is also coupled to a motion detector 37 that produces a motion signal M in response to motion in NTSC signal 130. Motion signal M provides, illustratively, a constant level output during each frame time of NTSC signal 130 outside the vertical blanking interval. The voltage level of signal M in each frame is indicative of the degree of motion in the picture scene. Motion signal M controls the gain factor K of gain control devices 41 and 35, respectively. An illustrative embodiment of motion detector 37 is described later on in detail with reference to Figure 3.

FIGURE 4 illustrates two examples of the dependency of gain factor K of each of gain controlled devices 35 and 41 on motion signal M. In the first example which is illustrated by the dashed line in FIGURE 4, K assumes one of two possible states. When motion signal M exceeds a threshold level M1, K is equal to zero. Otherwise, it is equal to a predetermined value, such as K > 1. Here K exhibits an abrupt change between the two states. In the second example which is illustrated by the solid line, the gain factor K decreases gradually when M exceeds a threshold level M1. Threshold level M1, in the two examples, is established to minimize the effects of noise. When motion signal M exceeds level M1 in the first example, or level M2 in the second example, vertical detail enhancement is omitted. On the other hand, when motion signal M is at a level which is lower than M1, as illustrated in FIGURE 4, corresponding to no substantial degree of motion in the picture scene, the enhancement of vertical detail is at a maximum.

As explained before, vertical detail enhancement is omitted or diminished under motion conditions in order to reduce the visibility of artifacts that are attributable to aliasing components in NTSC signal 130 produced at the source of NTSC signal 130. It should be understood that the function, representing the variations of gain factor K of devices 41 or 35, or of both, relative to motion signal M, may be chosen to provide a tradeoff between the extent of reduction of the aliasing component induced artifacts and the extent of picture sharpness in the presence of motion.

FIGURE 2a illustrates the well-known frequency spectrum of NTSC signal 130 of FIGURE 1 representing a stationary picture. Note that in the vicinity of odd multiples of one-half the horizontal line frequency f_H = 15734 Hz, of incoming NTSC signal 130, there is negligible spectral content; whereas spectral energy may appear at an integer or zero multiple of the frequency f_H = 15734 Hz and at sidebands spaced by multiples of the frame rate of 30 Hz above and below. Also note that in the absence of motion, the first sideband may appear at 30 Hz. The energy in the sidebands that are further away from a given multiple of f_H is reduced, for example, in exponential manner.

FIGURE 2b illustrates the frequency spectrum of NTSC signal 130 of FIGURE 1 representing a non-stationary picture. In contrast to the situation illustrated in FIGURE 2a, here the spectral content of sidebands that are further away from a given multiple of f_H is not negligible. For example, the spectral content in the vicinity of odd multiples of one-half the horizontal scanning frequency is not negligible. In addition, sidebands appear in frequencies that are not present for a stationary picture; for example, spectral content appears between f = 0 and f = 30 Hz. The concept behind the illustrative embodiment of the motion detector of FIGURE 3 is that motion signal M is made to be indicative of the spectral content that is created as a result of motion. For example, the presence of energy in a portion of the spectrum of NTSC signal 130 between f = 0 and f = 30 Hz is indicative of motion.

FIGURE 3a illustrates the embodiment of motion detector 37 as decsribed in detail in U.S.-A-4641 186 RCA Docket No. 80,900 entitled, MOTION DETECTOR THAT EXTRACTS MOTION INFORMATION FROM SIDEBANDS OF BASEBAND TELEVISION SIGNAL, in the name of D. H. Pritchard. FIGURES 3b and c illustrate timing diagrams helpful in explaining motion detector 37 of FIGURE 3a. Identical numbers in FIGURES 1 and 3a-c indicate similar items or functions. In FIGURE 3a, vertical detail signal Yd that is combed is coupled through a wiper k of a switch 55 and through a low pass filter 52, having a cutoff fre-

quency of illustratively 30 Hz, the vertical rate, to form motion sidebands representative signal Sm at a terminal 52a. Note that signal Yd contains no component at zero frequency because of the combing process that is accomplished in separator 15.

FIGURE 5 illustrates a transfer function A representing the ratio, as a function of frequency, between the absolute values of the input signal at terminal 52a of FIGURE 3a and that of the signal at terminal 11 of FIGURE 1. From FIGURE 5 it is apparent that only the low end of the spectrum of NTSC signal 130 of FIGURE 1 is coupled to terminal 52a of FIGURE 3 to form signal Sm. Because spectral content of NTSC signal 130 of FIGURE 1 between f = 0 and f = 30 Hz appears only in the case of motion in the picture scene, the amplitude of signal Sm is indicative of motion in the picture scene.

Signal Sm is coupled to a peak detector 53 which produces a signal Smp indicative of the absolute value of the peak voltage of signal Sm. Signal Smp is coupled to a sample and hold circuit 54 which stores the level of signal Smp at the beginning of every other vertical retrace period to produce motion signal M, as illustrated by the dashed lines in FIGURE 3b. Each of sample and hold circuit 54 and peak detector 53 of FIGURE 3a may be controlled by pulses 21b of FIGURE 3a that occur at the beginning of every other vertical retrace period, as illustrated in FIGURE 3c. Pulses 21b may be derived from vertical blanking interval pulses V_{bl}, conventionally derived. Pulses V_{bl} are illustrated schematically by the pulses 21a and b in FIGURE 3c. Pulses V_{bl} are coupled through a flip-flop 56 of FIGURE 3a to provide one pulse 21b for every pair of pulses V_{bl}.

Peak detector 53 may include a capacitor, not illustrated in FIGURE 3a, which is charged to the absolute value of the peak voltage of signal Sm during each period of 1/30 of a second and rich is discharged under the control of pulse 21b, as illustrated by the solid lines in FIGURE 3b. Thus the voltage of signal Smp of FIGURE 3a and b may represent the peak voltage of signal Sm during the preceding 1/30 of a second. Detector 37 of FIGURE 3a extracts motion information from sidebands of NTSC signal 130 between f = 0 and f = 30 Hz. Pulses 21b appear every 1/30 of a second, which is sufficient time for obtaining the peak voltage of the sidebands below f = 30 HZ to produce signal Smp. These sidebands are indicative of motion because only non-stationary picture scene causes NTSC signal 130 to contain sidebands between f = 0 Hz and f = 30 Hz.

Switch 55 of FIGURE 3a blocks NTSC signal 130 during each vertical blanking interval from being coupled to low pass filter 52. This is done under the control of vertical blanking interval pulse V_{bl} to cause only active picture video lines to affect motion signal M.

Although the present invention has been described by way of example with reference to the motion detector 37 of Figure 3, it should be understood that a known motion detector may be suitable, such as a motion detector which utilizes a frame or field store to compare corresponding video lines of NTSC 130 from different frames for identifying motion when the respective video lines do not match.

In such known motion detectors which utilize field or frame stores, video lines of consecutive fields or frames are directly and simultaneously compared or subtracted to form a motion signal. Such direct simultaneous operation between two video lines which are separated by a field time or by a frame time is not required in motion detector 37 of FIGURE 3a. Motion detector 37 of FIGURE 3a extracts information from sidebands which appear only when motion occurs. Because motion information is obtained from the frequency spectrum of NTSC signal 130, of FIGURE 1, motion detector 37 of FIGURE 3a requires no direct simultaneous comparison of video lines that are a field or a frame apart.

Claims

1. A television apparatus (150) for processing a composite color video signal (130) which represents picture information comprising:

comb filter means (17,18,19) for separating said video signal into a first luminance signal (Yl) and a chrominance signal (Ci);

low pass filter means (36) to which the chrominance signal is supplied for producing a picture detail signal (Yd) which is representative of vertical picture detail missing in the first luminance signal;

means (37) for producing a signal (M) which is indicative of motion in the picture; and

means (35,33) for combining said picture detail signal (Yd) with said first luminance signal (Yl) in accordance with said motion indicative signal (M), to form a second luminance signal (Yb) containing enhanced vertical picture detail, the proportion of said picture detail signal (Yd) in the second luminance signal (Yb) being inversely related to the amount of motion in the picture as indicated by the motion indicative signal (M).

2. Apparatus as recited in claim 1 wherein said motion indicative signal producing means (37) includes a filter (52) for extracting a portion of the frequency spectrum of said television sig-

quency of illustratively 30 Hz, the vertical rate, to form motion sidebands representative signal Sm at a terminal 52a. Note that signal Yd contains no component at zero frequency because of the combing process that is accomplished in separator 15.

FIGURE 5 illustrates a transfer function A representing the ratio, as a function of frequency, between the absolute values of the input signal at terminal 52a of FIGURE 3a and that of the signal at terminal 11 of FIGURE 1. From FIGURE 5 it is apparent that only the low end of the spectrum of NTSC signal 130 of FIGURE 1 is coupled to terminal 52a of FIGURE 3 to form signal Sm. Because spectral content of NTSC signal 130 of FIGURE 1 between f ≈ 0 and f ≈ 30 Hz appears only in the case of motion in the picture scene, the amplitude of signal Sm is indicative of motion in the picture scene.

Signal Sm is coupled to a peak detector 53 which produces a signal Smp indicative of the absolute value of the peak voltage of signal Sm. Signal Smp is coupled to a sample and hold circuit 54 which stores the level of signal Smp at the beginning of every other vertical retrace period to produce motion signal M, as illustrated by the dashed lines in FIGURE 3b. Each of sample and hold circuit 54 and peak detector 53 of FIGURE 3a may be controlled by pulses 21b of FIGURE 3a that occur at the beginning of every other vertical retrace period, as illustrated in FIGURE 3c. Pulses 21b may be derived from vertical blanking interval pulses V_{bi}, conventionally derived. Pulses V_{bi} are illustrated schematically by the pulses 21a and b in FIGURE 3c. Pulses V_{bi} are coupled through a flip-flop 56 of FIGURE 3a to provide one pulse 21b for every pair of pulses V_{bi}.

Peak detector 53 may include a capacitor, not illustrated in FIGURE 3a, which is charged to the absolute value of the peak voltage of signal Sm during each period of 1/30 of a second and rich is discharged under the control of pulse 21b, as illustrated by the solid lines in FIGURE 3b. Thus the voltage of signal Smp of FIGURE 3a and b may represent the peak voltage of signal Sm during the preceding 1/30 of a second. Detector 37 of FIGURE 3a extracts motion information from sidebands of NTSC signal 130 between f = 0 and f = 30 Hz. Pulses 21b appear every 1/30 of a second, which is sufficient time for obtaining the peak voltage of the sidebands below f = 30 HZ to produce signal Smp. These sidebands are indicative of motion because only non-stationary picture scene causes NTSC signal 130 to contain sidebands between f = 0 Hz and f = 30 Hz.

Switch 55 of FIGURE 3a blocks NTSC signal 130 during each vertical blanking interval from being coupled to low pass filter 52. This is done under the control of vertical blanking interval pulse V_{bi} to cause only active picture video lines to affect motion signal M.

Although the present invention has been described by way of example with reference to the motion detector 37 of Figure 3, it should be understood that a known motion detector may be suitable, such as a motion detector which utilizes a frame or field store to compare corresponding video lines of NTSC 130 from different frames for identifying motion when the respective video lines do not match.

In such known motion detectors which utilize field or frame stores, video lines of consecutive fields or frames are directly and simultaneously compared or subtracted to form a motion signal. Such direct simultaneous operation between two video lines which are separated by a field time or by a frame time is not required in motion detector 37 of FIGURE 3a. Motion detector 37 of FIGURE 3a extracts information from sidebands which appear only when motion occurs. Because motion information is obtained from the frequency spectrum of NTSC signal 130, of FIGURE 1, motion detector 37 of FIGURE 3a requires no direct simultaneous comparison of video lines that are a field or a frame apart.

Claims

1. A television apparatus (150) for processing a composite color video signal (130) which represents picture information comprising:

   comb filter means (17,18,19) for separating said video signal into a first luminance signal (Yl) and a chrominance signal (Cl);

   low pass filter means (36) to which the chrominance signal is supplied for producing a picture detail signal (Yd) which is representative of vertical picture detail missing in the first luminance signal;

   means (37) for producing a signal (M) which is indicative of motion in the picture; and

   means (35,33) for combining said picture detail signal (Yd) with said first luminance signal (Yl) in accordance with said motion indicative signal (M), to form a second luminance signal (Yb) containing enhanced vertical picture detail, the proportion of said picture detail signal (Yd) in the second luminance signal (Yb) being inversely related to the amount of motion in the picture as indicated by the motion indicative signal (M).

2. Apparatus as recited in claim 1 wherein said motion indicative signal producing means (37) includes a filter (52) for extracting a portion of the frequency spectrum of said television sig-

nal that contains substantial spectral-information only when motion occurs in the picture scene (Fig 2b).

3. Apparatus as recited in claim 2 wherein the extracted portion of the frequency spectrum of said television signal is between zero and the lowest sideband of said television signal which occurs when said television signal contains picture information representing a stationary picture (Figs. 2a,2b).

4. Apparatus as recited in claim 2 or 3 wherein said motion indicative signal producing means (37) is coupled to receive the picture detail (Yd) signal and includes means (53,54) responsive to the signal (Sm) that is extracted from the detail signal (Yd) by said extracting filter (52) for producing as said motion indicative signal (M) a signal which varies in accordance with the amplitude of said detail signal (Yd) in the extracted portion of the frequency spectrum.

5. Apparatus as recited in any preceding claim wherein said combining means (33,35) adds the said proportion of the said picture detail signal (Yd) to the said first luminance signal (Yi) to form the said second luminance signal (Yb) which contains enhanced picture detail with a first polarity.

6. Apparatus as recited in claim 5 including a further combining means (39,41) for subtracting the said proportion of the said picture detail signal (Yd) from the said first (Yi) luminance signal to form a third signal (Ya) which contains enhanced picture detail with a second polarity opposite to the first polarity.

7. Apparatus as recited in claim 6 further comprising means (23) for compressing the time duration of a given video line of each of said second and third signals and means (43,51) for displaying the picture information of the time compressed video lines (Y2H) of said second (Yb) and third (Ya) signals, in successive display lines to obtain a non-interlaced display.

Revendications

1. Un récepteur de télévision (150) pour traiter un signal vidéo en couleurs, composite (130) qui représente une information d'image comprenant :

des moyens de filtre en peigne (17, 18, 19) pour diviser ledit signal vidéo en un premier signal de luminance (Yi) et un signal de chrominance (Ci) ;

des moyens de filtre passe-bas (36) auxquels le signal de chrominance est appliqué pour produire un signal de détail vertical (Yd) qui est représentatif d'un détail d'image vertical manquant dans le premier signal de luminance ;

des moyens (37) pour produire un signal (M) qui est indicatif d'un mouvement dans l'image ;

des moyens (35, 33) pour combiner le signal de détail d'image (Yd) avec ledit premier signal de luminance (Yi) en accord avec le signal indicatif de mouvement (M) pour former un second signal de luminance (Yb) contenant un détail d'image vertical augmenté, la proportion dudit signal de détail d'image (Yd) dans le second signal de luminance (Yb) étant inversement reliée à l'importance du mouvement dans l'image comme indiqué par le signal indicatif de mouvement (M).

2. Récepteur selon la revendication 1, dans lequel les moyens producteurs de signal indicatif de mouvement (37) comprennent un filtre (52) pour extraire une portion du spectre de fréquence du signal de télévision qui contient une information spectrale substantielle seulement lorsqu'un mouvement se produit dans la scène d'image (Figure 2b).

3. Récepteur selon la revendication 2, dans lequel la portion extraite du spectre de fréquences du signal de télévision est comprise entre zéro et la bande latérale la plus basse du signal de télévision qui se produit lorsque le signal de télévision contient une information d'image représentant une image stationnaire (figures 2a, 2b).

4. Récepteur selon la revendication 2 ou 3, dans lequel les moyens producteurs de signal indicatif de mouvement (37) sont reliés pour recevoir le signal de détail d'image (Yd) et comprennent des moyens (53, 54) sensibles au signal (Sm) qui est extrait du signal de détail (Yd) par ledit filtre d'extraction (52) pour produire comme signal indicatif de mouvement (M) un signal qui varie en accord avec l'amplitude du signal de détail (Yd) dans la portion extraite du spectre de fréquences.

5. Récepteur selon l'une des revendications précédentes, dans lequel les moyens de combinaison (33, 35) additionnent la proportion précitée du signal de détail d'image précité (Yd) au premier signal de luminance (Yi) précité pour former le second signal de luminance

(Yd) précité qui contient le détail d'image augmenté avec une première polarité.

6. Récepteur selon la revendication 5, comprenant un autre moyen de combinaison (39, 41) pour soustraire la proportion précitée du signal de détail d'image (Yd) précité du premier signal de luminance (Yi) précité pour former un troisième signal (Ya) qui contient le détail d'image augmenté avec une seconde polarité opposée à la première polarité.

7. Appareil selon la revendication 6, comprenant en outre des moyens (23) pour comprimer la durée de temps d'une ligne vidéo donnée de chacun des second ou troisième signaux précités et des moyens (43, 51) pour visualiser l'information d'image des lignes vidéo comprimées dans le temps (Y2H) des second (Yb) et troisième (Ya) signaux précités, dans des lignes de visualisation successives pour obtenir une visualisation ou une reproduction non-entrelacée.

Patentansprüche

1. Fernsehgerät (150) zur Verarbeitung eines Farbvideosignalgemisches (130), das Bildinformation darstellt, mit:

einer Kammfilteranordnung (17, 18, 19) zum Aufteilen des Videosignals in ein erstes Leuchtdichtesignal (Yi) und ein Farbartsignal (Ci);

einer Tiefpaßfilteranordnung (36), der das Farbartsignal zugeführt ist, um ein Bilddetailsignal (Yd) zu erzeugen, das für vertikale Bilddetails repräsentativ ist, die im ersten Leuchtdichtesignal fehlen;

einer Anordnung (37) zum Erzeugen eines Signals (M), welches eine Bewegung im Bild anzeigt, und

einer Anordnung (35, 33) zum Kombinieren des Bilddetailsignals (Yd) mit dem ersten Leuchtdichtesignal (Yi) entsprechend dem bewegungsanzeigenden Signal (M), um ein zweites Leuchtdichtesignal (Yb) zu erzeugen, welches angehobene vertikale Bilddetails enthält, wobei der Anteil des Bilddetailsignals (Yd) im zweiten Leuchtdichtesignal (Yb) in inverser Beziehung zum Betrag der Bewegung im Bild, die durch das bewegungsanzeigende Signal (M) angezeigt wird, ist.

2. Gerät nach Anspruch 1, **dadurch gekennzeichnet**, daß die das bewegungsanzeigende Signal erzeugende Anordnung (37) ein Filter (52) enthält, um einen Teil des Frequenzspektrums des Fernsehsignals zu extrahieren, der nennenswerte Spektralinformation nur dann enthält, wenn in der Bildszene eine Bewegung auftritt (Fig. 2b).

3. Gerät nach Anspruch 2, **dadurch gekennzeichnet,** daß der extrahierte Teil des Frequenzspektrums des Fernsehsignales zwischen null und dem untersten Seitenband des Fernsehsignals liegt, das auftritt, wenn das Fernsehsignal Bildinformation, die ein stationäres Bild darstellt, enthält (Fig. 2a, 2b).

4. Gerät nach Anspruch 2 oder 3, **dadurch gekennzeichnet,** daß die das bewegungsanzeigende Signal erzeugende Anordnung (37) für einen Empfang des Bilddetailsignals (Yd) geschaltet ist und eine Anordnung (53, 54) enthält, die auf das aus dem Detailsignal (Yd) durch das extrahierende Filter (52) extrahierte Signal (M) anspricht, um als bewegungsanzeigendes Signal (M) ein Signal zu erzeugen, welches sich entsprechend der Amplitude des Detailsignals (Yd) im extrahierten Teil des Frequenzspektrums ändert.

5. Gerät nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** daß die Kombinieranordnung (33, 35) den genannten Anteil des Bildetailsignals (Yd) zu dem genannten ersten Leuchtdichtesignal (Yi) addiert, um das zweite Leuchtdichtesignal (Yb) zu erzeugen, welches angehobene Bilddetails mit einer ersten Polarität enthält.

6. Gerät nach Anspruch 5, **gekennzeichnet durch** eine weitere Kombinieranordnung (39, 41) zum Subtrahieren des genannten Anteiles des Bilddetailsignals (Yd) vom ersten Leuchtdichtesignals (Yi), um ein drittes Signal (Ya) zu bilden, welches angehobene Bilddetails mit einer zweiten, der ersten Polarität entgegengesetzten Polarität enthält.

7. Gerät nach Anspruch 6, weiterhin **gekennzeichnet durch** eine Anordnung (23) zum Komprimieren der zeitlichen Dauer einer gegebenen Videozeile des zweiten sowie des dritten Signals und eine Anordnung (43, 51) zum Wiedergeben der Bildinformation der zeitlich komprimierten Videozeilen (Y2H) des zweiten (Yb) und des dritten (Ya) Signals in aufeinanderfolgenden Wiedergabezeilen, um eine nichtverschachtelte Wiedergabe zu erhalten.