The invention concerns a method for separating luminance and chrominance signals from a PAL or SECAM composite video signal and a device for implementing this method. It is applied in PAL or SECAM standard television receivers, and also in any television equipment in which the separation of luminance and chrominance signals is carried out from a composite video signal.

In all the colour television systems there is provided a separation circuit which, from the composite video signal, supplies the luminance signal which represents the luminous intensity at each point of the image and also the chrominance signal which represents the colour of one point or of a group of points.

In the SECAM method, this separation is carried out by means of analog filters. The filter restoring the chrominance carrier is known as the "bell" filter in allusion to the shape of its gain curve as a function of the frequency. The filter supplying the luminance signal is known as the chrominance carrier rejector, because it eliminates this carrier, the frequency of which is generally 4.286 MHz. This separation method involves a certain number of disadvantages. On the one hand, the separation is imperfect and gives rise to chromatic crosstalk phenomena, known by the terms "cross-colour" and"cross-luminance" in the literature in English and, on the other hand, the restoration of the luminance information present in the composite video signal is lost in the frequencies whch are eliminated by the chrominance carrier rejector filter. Finally, this device, like any device of analogous type, is subject to problems of regulation and instability.

There has been proposed, for the SECAM method, a circuit for separating the luminance and chrominance signals, using the conventional analog method set forth above, by digital processing means. Such a circuit is described in the patent

application FR-A-2504766 filed in the name of the company THOMSON-BRANDT, and the improvements which are obtained are limited to those brought by digital techniques compared with analog techniques, namely the absence of regulation, stability, insensitivity to noise.

The conventional method used to separate the luminance and chrominance signals in the PAL method is identical to the method used in the SECAM method. From the analog composite video signal, the luminance signal is extracted, by attenuating the chrominance signal situated in the upper part of the spectrum of the composite signal, whilst the chrominance signal is obtained by selecting the upper part of the spectrum of the composite signal by a band-pass filter. These two filtering operations are put into operation by means of analog techniques and the disadvantages which are established are those already indicated in the case of the SECAM method.

There has been proposed in the framework of the PAL method a certain number of alternative methods for separating the luminance and chrominance signals, the common principle of which consists in carrying out a vertical comb filtering on the composite video signal of the type which is described for example in the European patent applications EP-A-0103128 and EP-A-0100967 filed in the name of TOKYO SHIBAURA DENKI KABUSHIKI KAISHA. These techniques make use of the fact that in PAL the chrominance signals are in phase opposition when a staggering of two lines is effected on the same frame. They allow the above-mentioned "cross-colour" and "cross-luminance" phenomena to be eliminated, and allow the high frequency luminance information to be restored in the zones of the image which do not contain vertical transitions. In the vicinity of vertical transitions, on the other hand, incorrect colours and transition shifts appear.

Possibly, a solution known from the Japanese patent

application JP.A.55 150-688 may in certain cases allow the "cross-colour" phenomenon to be eliminated, but this solution does not appear to be satisfactory for regulating the problems of transition on the contours of the image or due to movement in the image.

The present invention proposes remedying the above-mentioned "cross-colour" and "cross-luminance" phenomena and the loss of high frequency luminance information in the zones of images having neither strong vertical transitions nor transitions in movement of medium or high speed, whilst not introducing additional gradations in the vicinity of the marked vertical transitions and transitions in movement of medium or high speed.

For this purpose, the invention has as an object a method for separating luminance and chrominance signals from a PAL or SECAM composite video signal, characterized in that it consists in:

- sampling and digitizing a PAL or SECAM composite signal,
- determining in a first processor channel a luminance signal and a chrominance signal from the digital sample of the current image point and from an earlier sample homologous to the current point situated on the line in the preceding frame, which is spatially positioned in the image immediately under the current line,
- determining in a second processor channel a luminance signal and a chrominance signal by applying the digital composite signal to the inputs of a luminance filter and of a chrominance filter respectively,
- selecting the luminance and the chrominance signals present at the output of the first processor channel or of the second processor channel as a function of the analysis of the spatial-temporal local context of the point by detecting the contour or the movement of the current point in performing a luminance analysis.

The invention also has as an object a device for separating luminance and chrominance signals from a PAL or SECAM composite video signal, characterized in that it comprises:
- means for sampling and digitizing the PAL or SECAM analog composite video signal;
- a delay device adapted to delay, for the duration of about one frame, each digital sample supplied for the sampling means and the digitizing means,
- a first channel for extracting the luminance signals and the chrominance signals from the digital samples supplied by the sampling means and the digitizing means, and from the digital samples supplied by the delay device,
- a second channel for extracting the luminance signals and the chrominance signals, comprising a luminance filter and a chrominance filter for filtering the digital composite video signal supplied by the sampling means and the digitizing means,
- a selection means adapted to deliver at the output of the separation device the signals generated by the one or by the other of the channels for extracting the luminance and the chrominance signals,
- and a control means for generating control signals for the selection means by detecting the contour or the movement of the current point in performing a luminance analysis.

Apart from the fact that the invention remedies the phenomena of "cross-colour" and "cross-luminance" and of loss of high frequency luminance information, the digital techniques employed in implementing the invention bring the known advantages of digital techniques over analog techniques. Likewise, the invention also has the advantage that it allows the separation of the luminance and chrominance signals to be carried out in an identical manner from a PAL or SECAM composite video signal.

Its advantages result from the following considerations.

Let in fact two swept television lines with a time shift worth 312 times the duration of a television line, hereinafter named line n and line n-312, being situated in a frame preceding the frame of the line n, immediately beneath the line n and assuming Y_0 , C_0 and S_0 to be the luminance, chrominance and composite signals along the line n-312, and Y_1 , C_1 and S_1 the same signals along the line n. These signals are linked by the relationships:

$$S_1 = Y_1 + C_1 \text{ and } S_0 = Y_0 + C_0.$$

Both in PAL and in SECAM, in the absence of vertical transition or movement transition between the lines n-312 and n, the signals Y_1 and Y_0 are identical and the singals C_1 and C_0 are in phase opposition.

$$Y_1 = Y_0 \quad C_1 = - C_0$$

The luminance signals $\hat{Y}_{1A}$ and chrominance signals $\hat{C}_{1A}$ along the line n under these conditions can be estimated from composite signals S_1 and S_0 by implementing the following operations:

$$\hat{C}_{1A} = \frac{1}{2}(S_1 - S_0) = \frac{1}{2}(C_1 - C_0) + \frac{1}{2}(Y_1 - Y_0)$$

and

$$\hat{Y}_{1A} = S_1 - \hat{C}_{1A} = \frac{1}{2}(Y_1 + Y_0) + \frac{1}{2}(C_1 + C_0)$$

However, as this estimation becomes unacceptable since Y_1 and C_1 differ substantially from Y_0 and $- C_0$ respectively, which arises in the presence of a vertical transition or a movement transition between the lines n-312 and n, the method and the device according to the invention present the advantage that they allow the estimations $\hat{C}_{1A}$ and $\hat{Y}_{1A}$ to be validated when the difference in luminance between the lines n-312 and n remains less than a certain threshold and,

in certain cases in which this condition is not realised, they allow a luminance value $\hat{Y}_{IA}$ to be estimated at the point processed from luminance values already determined in a spatial-temporal vicinity of the point and as a function of an analysis of the spatial-temporal local context of the point processed, this analysis resulting from a contour detection/estimation and/or a movement detection/estimation considering, for example, the respective luminance values of the point preceding the current point processed of the same line and those of the points of a preceding interlaced frame, situated respectively above and below the current point, on two consecutive lines. The chrominance signal $\hat{C}_{IA}$ at the processed point is obtained in this case by subtracting the estimated luminance signal from the received composite signal:

$$\hat{C}_{IA} = S_I - \hat{Y}_{IA}$$

In other cases, in which the amplitudes of the luminance signals and of the chrominance signals vary quite strongly between the lines n-312 and n and in which the analysis of the spatial-temporal context of the processed point does not allow a satisfactory estimation to be obtained of the luminance at this point, the luminance signals $\hat{Y}_{IB}$ and chrominance signals $\hat{C}_{IB}$ are estimated by filtering the composite video signal S_I by means of a luminance filter and by means of a chrominance filter which are produced by digital techniques.

Other characteristics and advantages of the invention will become apparent with the aid of the following description, which is made with regard to the attached drawings in which:

- figure 1 shows a diagram of a form of embodiment of the circuit for separating the luminance and chrominance signals according to the invention;

- figure 2 shows a diagram of a simplified form of embodiment of the separating circuit according to the invention;

- figure 3 shows a diagram of another simplified embodiment of the invention;

- figures 4 and 5 show two variant embodiments of the invention;

- figure 6 shows a more detailed diagram of a part of the embodiments presented in figures 2 and 3.

The circuit for separating the luminance and chrominance signals according to the invention, which is represented in figure 1, comprises a sampler circuit 1, an analog-digital converter 2, a delay device 3, a computing device 4, a luminance filter 5, a chrominance filter 6, a multiplexer 7, a memory 8, command means 9 and a spatial-temporal local context analyzer 10.

The sampler circuit 1 has a clock input 11 on which there is applied a clock signal of frequency F_e and an analog input 12 on which there is applied the video composite signal PAL and SECAM.

The output of the sampler circuit 1 is connected to an input of the analog-digital converter 2.

The delay device 3 is connected to the output of the analog-digital converter 2 and delays the signals supplied by the analog-digital converter 2 for a duration corresponding to a duration of sweeping a frame of 312 lines in the PAL or SECAM standards. The output of the delay device 3 is connected to a first input 13 of the computing device 4, a second input 14 of which is connected to the output of the analog-digital converter 2 and a third input

is connected to the output of the command means 9. The computing device 4 supplies at a first output 15 an estimation of the luminance signal $\hat{Y}_{IA}$ and applies the estimation $\hat{Y}_{IA}$ on a first input 16 of the multiplexer 7 and supplies on a second output 17 an estimation of the chrominance signal $\hat{C}_{IA}$ which is applied on a second input 18 of the multiplexer 7.
The luminance filter 5 is connected to the output of the analog-digital converter 2 and supplies at its output 19 an estimation $\hat{Y}_{IB}$ of the luminance signal which is applied on a third input 20 of the multiplexer 7.

The chrominance filter 6 is likewise connected by its input to the output of the analog-digital converter 2 and supplies on an output 21 an estimation of the chrominance signal $\hat{C}_{IB}$ which is applied on a fourth input 22 of the multiplexer 7.

The multiplexer 7 is commanded on a command input 23 by an output 24 of the command means 9, and supplies on an output 25 a chrominance signal C taken either at the output 17 of the computing device 4 or at the output 21 of the chrominance filter 6. Likewise the multiplexer 7 supplies at an output 26 a luminance signal Y taken either at the output 15 of the computing device 4 or at the output 19 of the luminance filter 5.

The output 26 of the multiplexer 7 is connected to a first addressing input 27 of the memory 8 which is commanded on a command input 28 by an output 29 of the command means 9.

The spatial-temporal local context analyzer 10 has a first input which is connected to the output of the memory 8 and a second input which is connected to the output 19 of the luminance filter 5, it supplies on an output 31 a status signal of the spatial-temporal context of each image point processed, and applies the status signal obtained on an input 32 of the command means 9.

A form of embodiment of the computing device 4 and a form of embodiment of the spatial-temporal context analyzer 10 and their connections with the other elements of the separation circuit represented in figure 1 are represented in figure 2, in which the analogous elements of figure 1 are given the same reference numbers. The computing device 4 which is represented in figure 2 within a dotted line comprises a subtractor circuit 35, a divider circuit 36 by 2 and a subtractor circuit 37.

The subtractor circuit 35 is connected by a first input to the output ofthe delay device 3 and by a second input to the output of the analog-digital converter 2. The output of the subtractor circuit 35 is connected on the one hand to the input of the divider circuit 36 which supplies the chrominance signal $\hat{C}_{1A}$ to apply it on the input 18 of the multiplexer 7 and on the other hand on a first operand input of the subtractor circuit 37. The subtractor circuit 37 is connected by its second operand input to the output of the analog-digital converter 2 and supplies on its output an estimation of the luminance signal $\hat{Y}_{1A}$ to apply it to the input 16 of the multiplexer 7.

By designating, as previously, by Y_0 , C_0 and S_0 the luminance, chrominance and composite signals along the line n-312 and by Y_1 , C_1 and S_1 the same signals along the line n, the subtractor circuit 35 and the divider circuit 36 by 2 carry out the calculation of the estimation of the chrominance signal by executing the operation

$$\hat{C}_{1A} = \frac{1}{2}(S_1 - S_0) = \frac{1}{2}(C_1 - C_0) + \frac{1}{2}(Y_1 - Y_0)$$

and the subtractor circuit 37 carries out the calculation of the estimation of the luminance signal by executing the operation

$$\hat{Y}_{1A} = S_1 - \hat{C}_{1A} = \frac{1}{2}(Y_1 + Y_0) + \frac{1}{2}(C_1 + C_0)$$

As in figure 1, the chrominance filter 6 supplies on its output 21 the estimation of the chrominance signal $\hat{C}_{1B}$ to apply it on the input 22 of the multiplexer 7 and the luminance filter 5 supplies on its output 19 the estimation of the luminance signal $\hat{Y}_{1B}$ to apply it on the input 20 of the multiplexer 7.

The multiplexer 7 delivers either the signals applied on the inputs 16 and 18, or the signals applied on the inputs 20 and 22 as a function of the status of the command signal which is applied on the selection input 23.

In the example embodiment of figure 2, the memory 8 is formed by a delay line which delays the luminance signal Y supplied by the output 26 of the multiplexer 7 for a duration equal to the passage time of a frame of 312 lines in the PAL or SECAM standards and its output is connected to a first input of the spatial-temporal analyzer 10 which is constituted in this example by a simple subtractor. The second input of the spatial-temporal analyzer 10 is connected to the output 19 of the luminance filter 5.

The spatial-temporal analyzer 10 supplies the difference between the estimation of the luminance signal $\hat{Y}_{1B}$ supplied by the luminance filter 5 and the luminance signal (Y(n-312) obtained at the output of the delay line 8. When this difference is small, the estimations $\hat{C}_{1A}$ and $\hat{Y}_{1A}$ supplied by the computing device 4 are validated by the command means 9 and the multiplexer 7. On the other hand, when the difference obtained is great, i.e. when the amplitudes of the luminance signals and chrominance signals vary very greatly between the lines n-312 and n, the command means 9 and the multiplexer 7 validate the estimations $\hat{C}_{1B}$ and $\hat{Y}_{1B}$ supplied by the chrominance and luminance filters 6 and 5.

A third variant embodiment of the device for separating luminance and chrominance signals according to the invention

is represented in figure 3. This variant embodiment differs from that of figure 2 in that it does not comprise a delay device 8 and in that, on the other hand, it comprises in addition a luminance filter 38 coupled between the first input of the subtractor circuit 10 and the output of the delay device 3.

Figures 4 and 5 illustrate variant embodiments of the computing device 4. In the computing device represented in figure 4, a band-pass filter 39_1 is intercalated between the output 1 of the divider by two 36 and the first input of the subtractor circuit 37.

On the other hand in the example of figure 5, it is a high-pass filter 39_2 which is intercalated.

Finally, figure 6 represents a more detailed embodiment of the command means 9 of figures 2 and 3. In this figure, a computing device 40 of absolute value receives at its input a binary representation of the algebraic number supplied by the subtractor 10 and supplies at its output the corresponding binary representation of the absolute value of this algebraic number. A comparator 41 is connected by a first input to the output of the computing device of absolute value 40 and receives on a second input a binary representation of a threshold S. The computing device 40 supplies at its output, in the direction of the command input of the multiplexer 7 of figures 2 and 3, a command signal resulting from the comparison between the threshold S and the absolute value of the binary number to validate, as previously indicated, either the chrominance signals $\hat{C}_{1A}$ and luminance signals $\hat{Y}_{1A}$ or the chrominance signals $\hat{C}_{1B}$ and luminance signals $\hat{Y}_{1B}$.

CLAIMS

1. A method for separating luminance and chrominance signals from a PAL or SECAM composite video signal, characterized in that it consists in:
- sampling (1) and digitizing (2) a PAL or SECAM composite signal,
- determining in a first processor channel (3,4) a luminance signal and a chrominance signal from the digital sample of the current image point and from an earlier sample homologous to the current point situated on the line in the preceding frame, which is spatially positioned in the image immediately under the current line,
- determining in a second processor channel (5,6) a luminance signal and a chrominance signal by applying the digital composite signal to the inputs of a luminance filter and of a chrominance filter respectively,
- selecting (7) the luminance and the chrominance signals present at the output of the first processor channel or of the second processor channel as a function of the analysis (10) of the spatial-temporal local context of the point by detecting the contour or the movement of the current point in performing a luminance analysis.

2. A device for separating luminance and chrominance signals from a PAL or SECAM composite video signal, characterized in that it comprises:
- means for sampling (1) and digitizing (2) the PAL or SECAM analog composite video signal;
- a delay device (3) adapted to delay, for the duration of about one frame, each digital sample supplied for the sampling means(1) and the digitizing means (2),
- a first channel (3,4) for extracting the luminance signals (Y_{IA}) and the chrominance signals (C_{IA}) from the digital samples supplied by the sampling means (1) and the digitizing means (2), and from the digital samples supplied by the delay device (3),

- a second channel (5,6) for extracting the luminance signals and the chrominance signals, comprising a luminance filter (5) and a chrominance filter (6) for filtering the digital composite video signal supplied by the sampling means (1) and the digitizing means (2),
- a selection means (7) adapted to deliver at the output of the separation device the signals generated by the one or by the other of the channels (3,4,5,6) for extracting the luminance and the chrominance signals,
- and a control means (9) for generating control signals for the selection means (7) by detecting the contour or the movement of the current point in performing a luminance analysis.

3. A device according to claim 2, characterized in that the first extraction channel (3,4) comprises a computing device (4) for generating a chrominance signal by effecting the half-difference between the signals present respectively at the input and at the output of the delay device (3).

4. A device according to claim 3, characterized in that the chrominance signal is filtered inside the computing device (4) by a band-pass filter (39_1) prior to being substracted from the signal present at the input of the delay device (3).

5. A device according to claim 3, characterized in that the chrominance signal is filtered by a high-pass filter (39_2) prior to being substracted from the signal present at the input of the delay device (3).

6. A device according to claim 2, characterized in that the control of the selection means (7) is obtained on the one hand from the luminance signal provided at the output of the selection means (7) and delayed for the duration of one frame, and on the other hand from the luminance signal provided by the second extraction channel (6).

7. A device according to claim 2, characterized in that the control of the selection means (7) is obtained on the one hand from the luminance signal provided by the second extraction channel (6), and on the other hand from the luminance signal obtained by filtering (38) the digital composite video signal obtained at the output of the delay means (3).

8. A device according to either one of claims 6 and 7, characterized in that the control of the selection means (7) is obtained from a test signal resulting from the difference between the two luminance signals.

9. A device according to claim 8, characterized in that the control of the selection means (7) is obtained by computing the absolute value (40) of the number represented by the test signal, and by comparison (41) of said absolute value with a threshold (S).