

(21) Application No 9319564.2

(22) Date of Filing 22.09.1993

(30) Priority Data

(31) 9211330

(32) 23.09.1992

(33) FR

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(51) INT CL<sup>5</sup>

H04N 5/14

(52) UK CL (Edition M )

H4F FD1B7 FD1D1 FD30J FD30K FD30M1 FD30R  
FD30T1 FD30T2 FGM

(56) Documents Cited

EP 0210861 A

EP 0181215 A

US 5166788 A

US 5128750 A

US 5068722 A

(58) Field of Search

UK CL (Edition L ) H4F FGM

INT CL<sup>5</sup> H04N

(54) Image motion estimation using a composite digital input

(57) For obtaining motion information by using a convention motion estimator, a composite signal obtained from both the luminance signal and the chrominance signal is applied to this motion estimator. Based on the signals (Cb, Cr) of the two chrominance components (U, V), the contour of the colored elements of the image is extracted by means of Sobel filters (9, 10), i.e. high-pass two dimensional filters generating colour contours, and the output signals of these filter are added to the luminance signal (2) in an adder (14), the resultant signal (3) being applied to the motion estimator.

The method ensures the detection of motion even when luminance is constant across an image without the need for separate luminance and chrominance motion detectors.

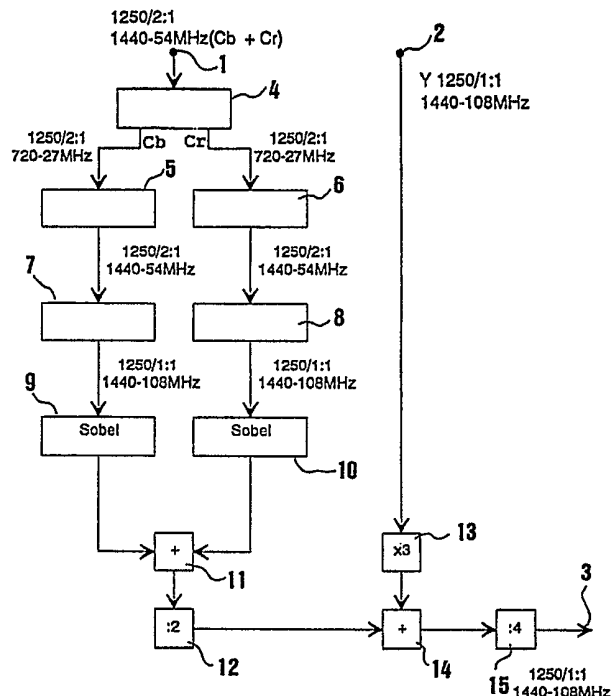


FIG.1

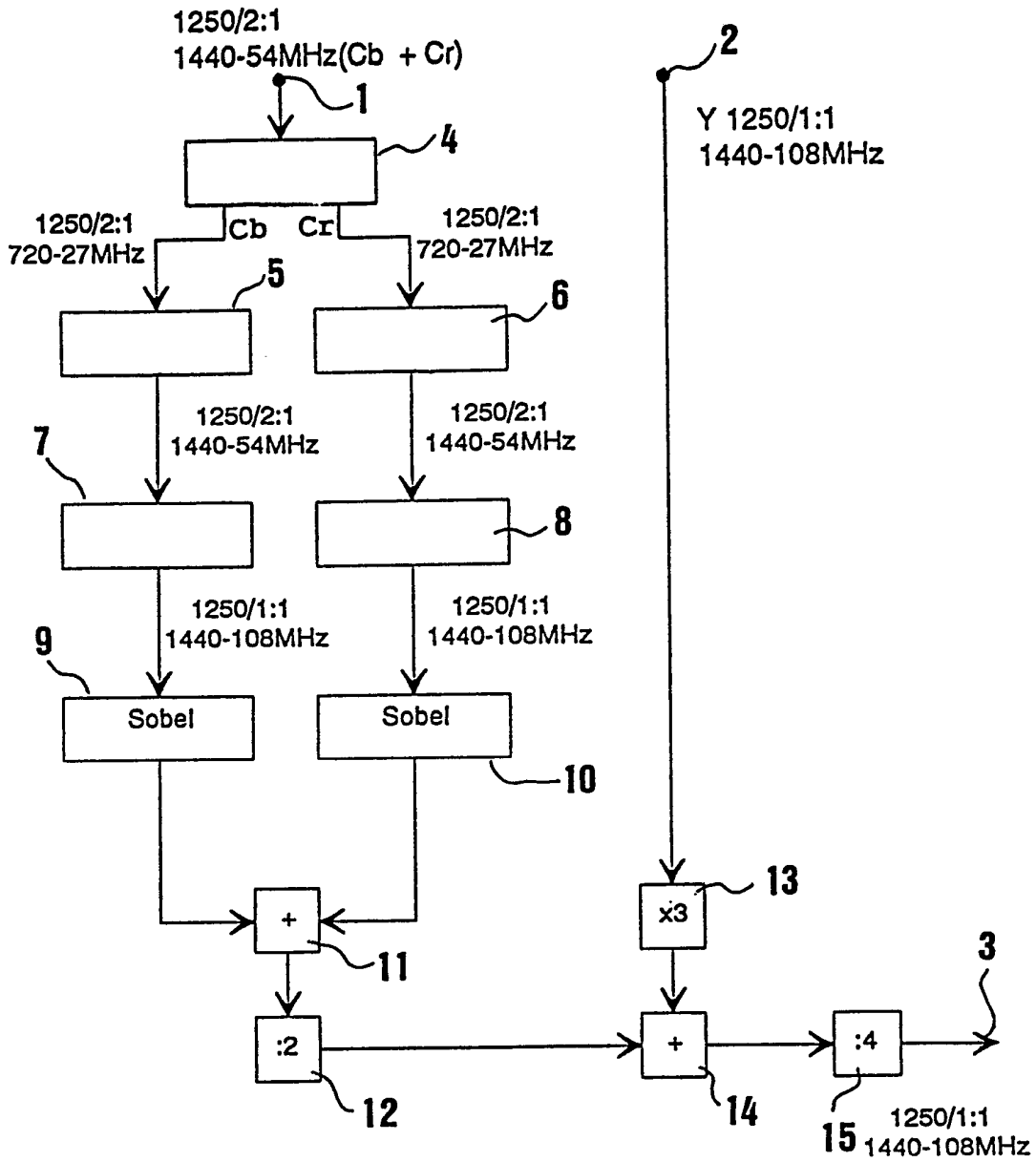


FIG.1

A0	A1	A2
A7	F	A3
A6	A5	A4

FIG.2

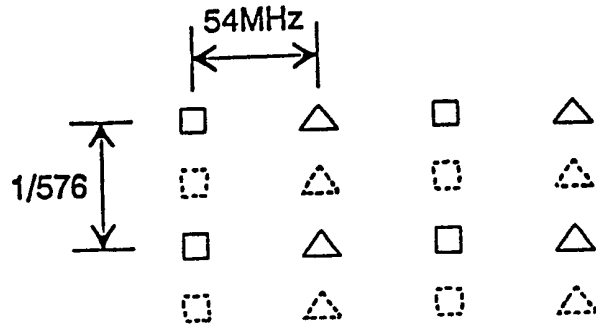


FIG.3

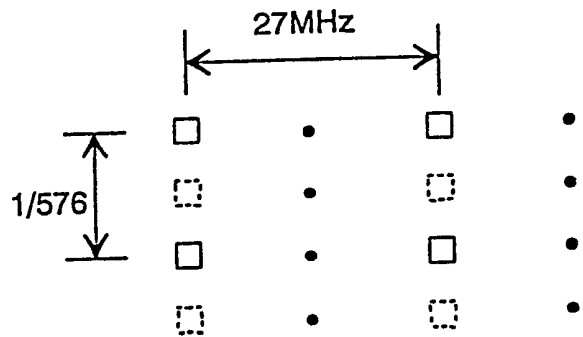


FIG.4

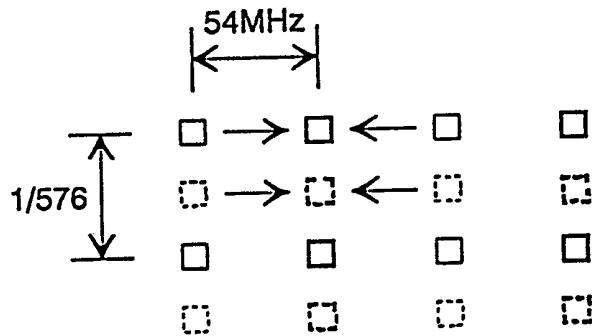


FIG.5

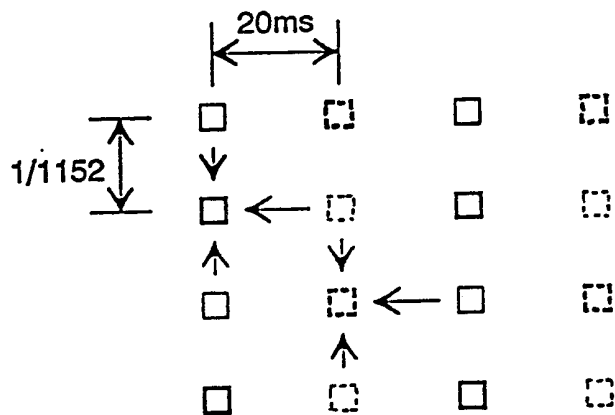


FIG.6

Method of and device for estimating motion in an image.

The invention relates to a method of estimating motion in an image by means of a motion estimator whose input receives a signal which supplies information about the pixels of the image, said image being represented by digital data comprising a luminance signal and a chrominance signal.

5           The invention also relates to a device provided with a motion estimator whose input receives a signal which supplies information about the pixels of an image for estimating motion in this image which is represented by digital data comprising a luminance signal and a chrominance signal.

Such a method and a device are used for reducing the digital data rate in  
10 digital television or in television using associated digital data ("DATV").

It is known to obtain motion information for elements of a television image by using a motion estimator, based on the luminance signal, which supplies a  
15 vector motion for the luminance. However, when the luminance is constant when the chrominance signal level varies (for example, when moving the camera along banners against a uniform sky, with the luminance of the banner and that of the sky being equal or substantially equal, billboards, *etc.*) the motion estimator will operate erroneously, which becomes manifest in a disturbing phenomenon in the reproduced image. An  
20 evident solution would be to use a second motion estimator, based on the chrominance signal, supplying a vector motion for the chrominance, and to transmit the value of the chrominance vector motion, or to weight the luminance vector by the chrominance vector.

These options have the drawback that they are difficult to realise in  
25 hardware, while they also involve a modification of the data transmission standard.

It is, inter alia, an object of the invention to mitigate these drawbacks.

5 The invention provides a method of estimating motion in an image by means of a motion estimator whose input receives a signal which supplies information about the pixels of the image, said image being represented by digital data comprising luminance signal and a chrominance signal, comprising the steps of generating a composite signal not only from the luminance signal but also from the chrominance signal, and applying the composite  
10 signal to the input of the motion estimator.

For generating this composite signal, the chrominance signal may be filtered in a high-pass two-dimensional filter supplying the absolute value of the derivative of the signal, i.e. the contour of the colour elements of the image.

15 The use of a two-dimensional filter allows detection of contours in all the directions in an image.

A two-dimensional "Sobel" filter may be used. This type of filter is one of the easiest for realising the desired function.

20 The chrominance signal may also be filtered in a horizontal interpolation filter and in a vertical interpolation filter. Thereby, the sampling rate of the colour samples supplied at the output of these filters is made equal to that of the luminance samples, which enables the colour samples at the output of the two-dimensional filter(s) to be added, in a  
25 weighting operation, to the luminance signal, the resultant signal being applied to the motion estimator.

As the chrominance signal comprises several components, a two-dimensional filter may be used for each chrominance signal component, and the output signals of these  
30 two-dimensional filters are added together.

The invention further provides a device comprising a motion estimator having an input for receiving a signal which supplies information about the pixels of an image for estimating  
35 motion in this image which is represented by the digital data

comprising a luminance signal and a chrominance signal, said device comprising means for extracting from the chrominance signal, elements representing contours of colored parts of the image, and means for adding these elements to the luminance signal which is applied to the motion estimator.

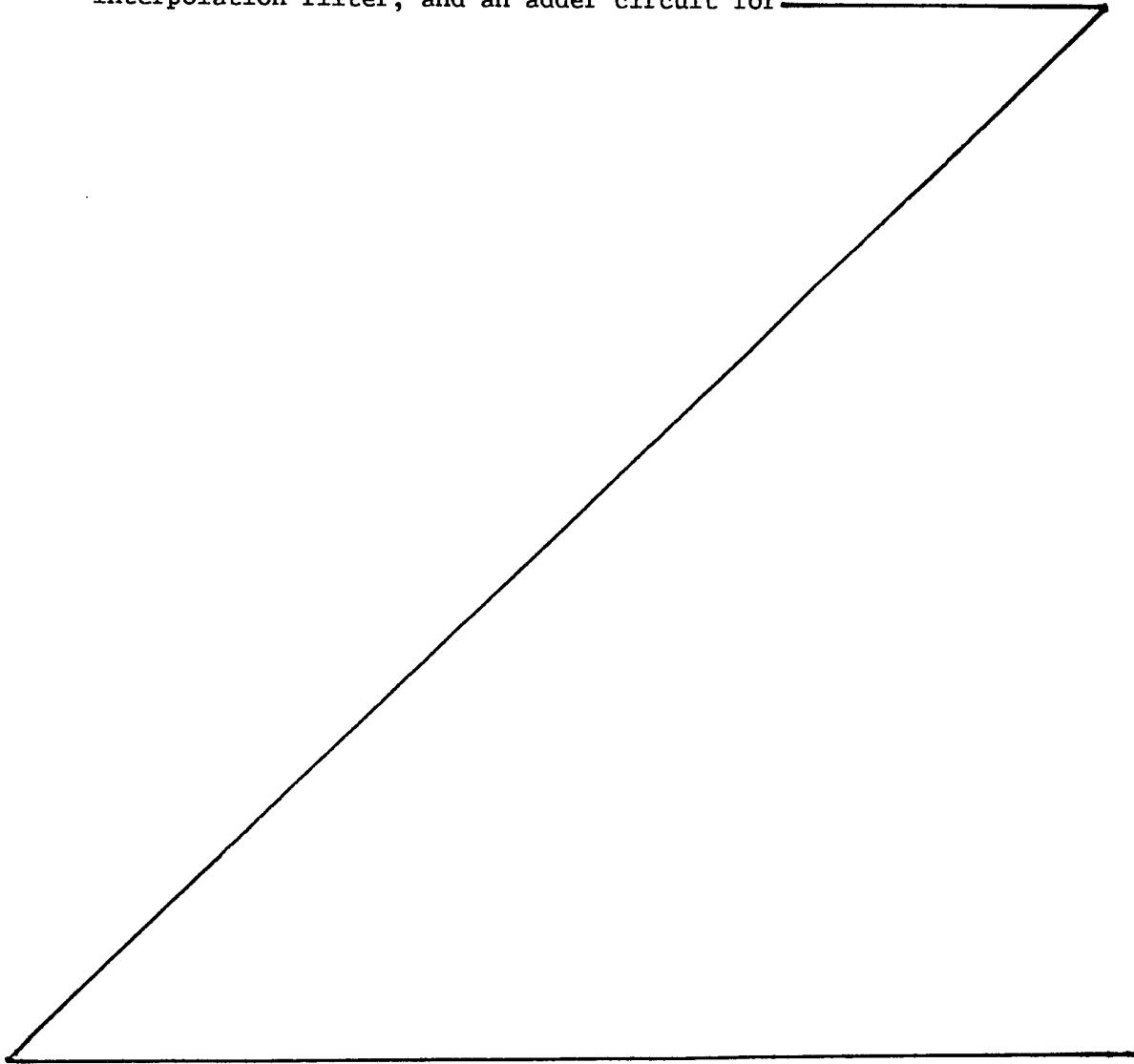
5

Said means for extracting the elements may comprise at least a high-pass two-dimensional filter which supplies the absolute value of the derivative of the chrominance signal.

The two-dimensional filter may be a "Sobel" filter.

10

The device may comprise, for the chrominance signal, at least a horizontal interpolation filter and a vertical interpolation filter, and an adder circuit for



adding, in a weighting operation, the signals from the two-dimensional filter to the luminance signal, the resultant signal being applied to the motion estimator.

As the chrominance signal comprises several components, the device may comprise a two-dimensional filter for each chrominance signal

- 5 component and an adder circuit for adding the output signals of the two-dimensional filters together.

These and other aspects of the invention will be apparent from and  
10 elucidated with reference to the embodiments described hereinafter, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram of a device according to the invention.

- 15 Figure 2 illustrates the configuration of samples treated in a Sobel filter used in the device.

Figure 3 to 6 illustrate the sampling of the signals at different points in the device.

20

The description of the operation of the device according to the invention provides a description of the method according to the invention, which will thus not be described separately.

- 25 The device shown in block schematic form in Figure 1 has an input terminal 1 for a multiplexed digital chrominance signal of the type 1250/2:1, with 1440 pixels per picture line and whose sampling frequency is 54 MHz. This signal alternately comprises a blue color sample referred to as "Cb" and a red color sample referred to as "Cr".

- The device also has an input terminal 2 for a digital luminance signal of the type 1250/1:1, with 1440 pixels per picture line and whose sampling frequency is  
30 108 MHz.

The input terminal 1 is connected to the input of a separating circuit 4 for separating the blue color samples Cb from the red color samples Cr. Consequently, this

circuit 4 has two outputs: one for the samples Cb and one for the samples Cr. Each of these signals now comprises 720 pixels per line, sampled at 27 MHz. The signal Cb is applied to the input of a filter 5 which is a horizontal interpolation filter and which doubles the number of samples per line and the sampling frequency, and is followed by  
5 a median filter 7 which is a vertical interpolation filter and doubles the sampling frequency again. Finally, the signal is applied to a 3 x 3 high-pass two-dimensional filter of the "Sobel" type, which will be described hereinafter.

The signal Cr from the separating circuit 4 is subjected to the same operations in the filters 6, 8, 10 which are identical to the filters 5, 7, 9, respectively.

10 The amplitudes of the output signals of the Sobel filters 9 and 10 are added in an amplitude adder 11, and subsequently the resultant amplitude of the signal is divided by two in an amplitude divider 12.

The amplitude of the luminance signal from the input terminal 2 is multiplied by three in an amplitude multiplier 13 and added in an amplitude adder 14 to  
15 the amplitude of the signal from the amplitude divider 12. It is to be noted that this is possible because the two signals whose amplitudes must be added have the same sampling frequency of 108 MHz and the same number of samples per line. The resultant signal from the amplitude adder 14 is finally applied to an amplitude divider 15 which divides the amplitude by four and finally supplies a signal at an output  
20 terminal 3, which signal is to be applied to a motion estimator (not shown), which may be of a prior-art type.

With the amplitude signals at the two inputs 1 and 2 united, the amplitude of the color signal is doubled because of the addition in the adder 11, and subsequently it is reduced to unity in the amplitude divider  
25 12. As the amplitude of the luminance signal is multiplied by three in the multiplier 13, the luminance and chrominance signals are added together with a weighting of three to one, respectively, yielding a signal of amplitude four which is reduced to unity in the divider 15.

The divider for dividing the amplitude by four is provided to bring the signal to the level required by a prior-art estimator. It is evident that the divider 15  
30 could be omitted if an estimator were constructed which would function with a signal which is four times larger than that required for prior-art estimators. Similarly, the values of the divisions or multiplications of the amplitude are mentioned by way of



example and may be modified, as desired, in accordance with the relative importance to be given to the luminance and chrominance components.

The Sobel filters 9 and 10 are filters whose outputs are defined by the following formula:

$$5 \quad \text{amplitude for the pixel } i, j = F = \sqrt{(X^2 + Y^2)}$$

where X and Y have the following values:

$$X = (A2 + 2 \cdot A3 + A4) - (A0 + 2 \cdot A7 + A6)$$

$$Y = (A0 + 2 \cdot A1 + A2) - (A6 + 2 \cdot A5 + A4)$$

the samples A1, A2, A3, etc. being eight samples of the signal. The notation in Figure 2  
10 represents the configuration in the image of the pixels whose samples are used. The amplitude F of the sample representing the pixel at position F in the Figure is thus generated from pixels situated on the preceding line (samples A0, A1, A2) and those bordering on the position F on the same line (samples A7, A3) and finally those on the following line (samples A6, A5, A4).

15 In a digital application it is easy to take into account that the filter supplies a positive pulse when a signal has a rising transition in whatever direction (horizontal, vertical or diagonal), and that the filter again supplies the same pulse when the signal has a descending transition. At the output of this filter the absolute value of the contours is thus obtained, *i.e.* the absolute value of the derivative of the amplitude  
20 for the colored parts of the image (for the blue colored parts: at the output of filter 9 and for the red colored parts: at the output of filter 10).

Figures 3 to 6 show sampling patterns of the image of pixels corresponding to the samples treated in the circuits described above.

Figure 3 illustrates the signal at the input of the separating circuit 4. The  
25 squares show samples of the blue color and the triangles show samples of the red color. The solid-line squares and triangles show the odd-field samples and the broken-line squares and triangles show the even-field samples. The sample rate is 54 MHz and there are two fields of 576 lines. The samples alternately represent the blue color and the red color and the picture is interlaced.

30 Figure 4 shows the signal at the input of the horizontal filter 5. All the symbols are squares and solely represent blue color samples. These are simply samples shown Figure 3 from which the red samples have been removed: small solid

circles also indicate the positions where the samples are absent. As 50% of the samples has been removed, the sampling rate is divided by two and is now 27 MHz. There are two fields of 576 lines.

Figure 5 illustrates the signal at the output of the horizontal filter 5. The squares in fat solid lines represent the interpolated samples created by the filter on the basis of the two samples bordering on the created sample. As hereinbefore, the solid-line squares represent the odd-field samples and the broken-line squares represent the even-field samples. The sample rate is again 54 MHz and there are two fields of 576 lines.

Figure 6 illustrates the signal at the output of the vertical interpolation median filter 7. The squares are the same, but the samples in fat solid lines now represent the interpolated samples created by the filter 7. A sample from the combination of three samples, as indicated by arrows, is inserted between two samples of a field: one of the three samples comes from the preceding line of the same field, another comes from the next line of the same field and the third comes from the next position of the same line of the next field. The indication "20 ms" between two successive samples of a line denotes that these samples come from two successive fields. The sample rate of these samples is again doubled and is now 108 MHz. The representation by way of interlaced lines is replaced by a representation by way of a simple picture of 1250 lines, like the representation of the luminance.

The different circuits whose functions have been defined hereinbefore (separating circuit 4, horizontal interpolation filters 5 and 6, vertical interpolation median filters 7 and 8, high-pass two-dimensional 3 x 3 filters of the "Sobel" type 9 and 10) are all of types known *per se* and can be realised by those skilled in the art.

It is clear that the above description with reference to a particular television system in this context is easily applicable to other systems whose characteristics, particularly those concerning the scanning mode or the number of pixels per line, or the number of components describing the color, are different.

Claims:

1. A method of estimating motion in an image by means of a motion estimator whose input receives a signal which supplies information about the pixels of the image, said image being represented by digital data comprising a luminance signal and a chrominance signal, comprising the steps of generating a composite signal  
5 not only from the luminance signal but also from the chrominance signal, and applying the composite signal to the input of the motion estimator.
2. A method as claimed in Claim 1, in which said generating step comprises the step of filtering the chrominance signal in a high-pass two-dimensional filter supplying the absolute value of the derivative of the signal, *i.e.* the contour of the  
10 colored elements of the image.
3. A method as claimed in Claim 2, in which a two-dimensional "Sobel" filter is used.
4. A method as claimed in Claim 2 or 3, in which said generating step further comprises the step of bidimensionally filtering the chrominance  
15 signal in a horizontal interpolation filter and in a vertical interpolation filter.
5. A method as claimed in any one of Claims 1 to 4, in which the chrominance signal comprises several components, a two-dimensional filter is used for each chrominance signal component, and the output signals of these two-dimensional filters are added together.
- 20 6. A method as claimed in claim 1, in which said generating step comprises the steps of filtering said chrominance signal, and adding said filtered chrominance signal, in a weighting operation, to the luminance signal, the resultant signal being the composite signal applied to the motion estimator.
7. A device comprising a motion estimator having an input for receiving a  
25 signal which supplies information about the pixels of an image for estimating motion in this image which is represented by digital data comprising a luminance signal and a chrominance signal, said device comprising means for extracting

from the chrominance signal, elements representing contours of colored parts of the image, and means for adding these elements to the luminance signal which is applied to the motion estimator.

8. A device as claimed in Claim 7, in which said means for  
5 extracting the elements comprise at least a high-pass two-dimensional filter which supplies the absolute value of the derivative of the chrominance signal.
9. A device as claimed in Claim 8, in which the two-dimensional filter is a "Sobel" filter.
10. A device as claimed in any one of Claims 7 to 9, comprising  
10 for the chrominance signal, at least a horizontal interpolation filter and a vertical interpolation filter.
11. A device as claimed in any one of Claims 8 to 10, in which the chrominance signal comprises several components, the device comprising a two-dimensional filter for each chrominance signal component and an adder  
15 circuit for adding the output signals of the two-dimensional filters together.
12. A device as claimed in claim 7, comprising a chrominance signal filter and an adder circuit for adding, in a weighting operation, the signals from the chrominance signal filter to the luminance signal, the resultant signal being applied to the motion estimator.
13. A method of estimating motion in an image substantially as described herein with reference to the accompanying drawings.
14. A device provided with a motion estimator whose input receives a signal which supplies information about the pixels of an image for estimating motion of this image which is represented by digital data comprising a luminance signal and a chrominance signal, the device being substantially as described herein with reference to the accompanying drawings.
15. Any novel feature or novel combination of features disclosed herein either explicitly or implicitly whether or not it relates to the same invention as that claimed in any preceding claim.

<b>Examiner's report to the Comptroller under Section 17 (The Search report)</b>	GB 9319564.2
<b>Relevant Technical Fields</b>	Search Examiner MISS S E WILLCOX
(i) UK Cl (Ed.L)      H4F (FGM)	
(ii) Int Cl (Ed.5)      H04N	Date of completion of Search 25 November 1993
<b>Databases (see below)</b> (i) UK Patent Office collections of GB, EP, WO and US patent specifications.  (ii)	Documents considered relevant following a search in respect of Claims :- 1,2,7

**Categories of documents**

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<b>A:</b> Document indicating technological background and/or state of the art.	<b>&amp;:</b> Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
X	EP 0210861      SONY page 6, lines 2-4	1
X	EP 0181215      SONY page 5, lines 4-19	1
X	US 5166788      LEE column 1, line 49 - column 2 line 40 and Figures 1,2	1
X	US 5128750      KATAGIRI Figure 2B	1
X	US 5068722      VICTOR column 2, lines 24-36, and Figure 1	1

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