

The invention relates to a colour television transmission system according to the preamble to Patent Claim 1.

In the standardized colour television systems, a non-linear distortion is effected at the camera side with the conversion of the tristimulus values into transmission primaries. This distortion is intended to "precorrect" the non-linearity which exists in the usual cathode-ray picture tubes and which leads to a gradation distortion (gamma error). The principle of such a known whole system is illustrated in Figure 1.

The colour stimulus specification of a picture element to be photographed is represented by standard tristimulus values X_1 , Y_1 and Z_1 . The television camera A (with filters F_{iR} , F_{iG} , F_{iB}) converts the radiation picked up, linearly into the primary colour signals E_{R01} , E_{G01} and E_{B01} , here assumed to be non-dimensional. These are predistorted in accordance with the relationships

$$E_{R1} = E_{R01}^{1/\gamma}; \quad E_{G1} = E_{G01}^{1/\gamma}; \quad E_{B1} = E_{B01}^{1/\gamma} \quad (1)$$

In which

$$E_{R01}, E_{G01}, E_{B01}, E_{R1}, E_{G1}, E_{B1} \in [0; 1] \quad (2)$$

The predistorted primary colour signals E_{R1} , E_{R2} , E_{R3} are converted linearly, by means of the coder matrix C, into a so-called luminance signal E_{Y1} and the chrominance signals E_{U1} and E_{V1} . In the further course (S), these signals are prepared for transmission, transmitted and converted back, and are again available at the reproduction side as E_{Y2} , E_{U2} and E_{V2} . The primary colour signals E_{R2} , E_{G2} and E_{B2} are obtained from these via the decoder matrix D to control the colour picture tube F. In the standardized system,

the camera colour filters Fi_R , Fi_G , Fi_B are matched to the reproduction fluorescent materials W ("phosphors" Ph_R , Ph_G , Ph_B) of the colour picture tube F. In addition, the coder matrix and the decoder matrix C and D respectively, are inverse to one another. If the luminance and the chrominance signals remain unaltered during the signal processing, transmission and restoration, the picture display standard tristimulus values X_2 , Y_2 and Z_2 coincide with the original values X_1 , Y_1 and Z_1 . If the transmitted luminance or chrominance signals are altered, this coincidence is disturbed.

Display faults result through alteration of the chrominance signals. This corresponds to the known fact that during the achromatic display of a colour picture, a reduction in luminance occurs. This reduction is particularly pronounced with high colour saturations and with those colours which in any case already have a low luminance, for example with the colour blue.

It is the object of the invention to avoid or to reduce this reduction in luminance.

This problem is solved by the invention characterised in Claim 1. Further developments of the invention are described in the dependent Patent Claims.

In order to explain the invention more fully, the problems are described by way of example with reference to the drawings.

Figure 1 shows the arrangement of a colour television system in principle,

Figures 2-4 show diagrams,

Figures 5, 6 show modifications of Figure 1 according to the invention,

Figure 7 shows a basic module,

Figure 8 shows the production of a chrominance component $E_{W1,2}$,

Figure 9 shows the determination of the correction signal ΔE_y by means of an approximation solution - estimated value,

Figure 10 shows an approximation solution of the first order,

Figure 11 shows an approximation solution of the second order,

Figure 12 shows a pipeline basic module,

Figure 13 shows an iterative solution by the successive approximation method,

Figure 14 shows a system for storing colour television signals and

Figure 15 shows an embodiment of the invention with an arrangement for storing colour television signals.

The conversion of the red, green and blue transmission primaries E_{R1} , E_{G1} and E_{B1} into the luminance signal E_{Y1} and the two chrominance signals E_{U1} and E_{V1} , introduced during the standardization of colour television systems, had the object, apart from reasons of compatibility with the already existing black-and-white television systems, of splitting up the total radiation into a component which essentially conveys the brightness or luminance, and into further components which essentially convey the colourfulness or chrominance. The splitting up of a radiation into luminance and chrominance is motivated by a characteristic of the human sense of sight which is indicated in Figure 2 with reference to the contrast sensitivity to chromaticity-modulated and luminance-modulated grids; the spatial frequency is plotted in pairs of lines/degrees in the abscissae and the relative contrast sensitivity in percentages in the ordinates (see, for example, H. Lang "Farbmetrik und Farbfernsehen", Munich and Vienna 1978, page 322). The curves BG, RG and H show the course

of the relative contrast sensitivity for the pairs of lines blue-yellow (BG), red-green (RG) and for brightness (H). According to this, the resolving capacity of the human sense of sight for differences in colour is only 10% to 20% of that for differences in brightness. The chrominance can therefore be reproduced with a reduced bandwidth in comparison with the luminance. This is the reason for the standardized bandwidth reductions of the chrominance signals. As a result of the signal processing in the plane of the gamma predistorted signals, the bandwidth reduction of the chrominance signals also leads to an influence on the display luminance. The display luminance is proportional to the tristimulus value Y_2 . Y_2 is therefore also called relative luminance. Y_2 is composed of the tristimulus values R_2 , G_2 and B_2 in accordance with the relationship:

$$Y_2 = b_R R_2 + b_G G_2 + b_B B_2 \text{ with } Y_2, R_2, G_2, B_2 \in [0;1] \quad (3)$$

The factors b_R , b_G , b_B depend on the standardized display colour stimulus specifications. The following applies for them

$$\text{in the } \begin{cases} \text{FCC standard: } b_R = 0.299; b_G = 0.587; b_B = 0.144 \\ \text{EBU standard: } b_R = 0.222; b_G = 0.707; b_B = 0.071 \end{cases}$$

In both standards: $b_R + b_G + b_B = 1$ applies (4)

In a manner corresponding to (3), the luminance signal is formed from the transmission primaries, for example

$$E_{Y2} = a_R E_{R2} + a_G E_{G2} + a_B E_{B2} \text{ with } E_{R2}, E_{G2}, E_{B2} \in [0;1] \quad (5)$$

In the FCC standard, the coefficients for the transmission primaries were equated with those for the tristimulus values, that is to say

$$a_R = b_R, a_G = b_G, a_B = b_B \quad (6)$$

For the EBU standard, the transmission primary coefficients were taken over from the FCC standard.

The relationships (6) are only approximately valid in the EBU standard. Since their validity makes the effects of variations in the chrominance signals more recognizable, it will be assumed for the further examination. Hereinafter, the so-called colour-difference signals

$$E_{B2}-E_{Y2} = E'_U; E_{R2}-E_{Y2} = E'_V, E_{G2}-E_{Y2} = E'_W \quad (7)$$

are used as chrominance signals.

Of the equations (7), two are linearly independent. Apart from this,

$$a_B * E'_U + a_R * E'_V + a_G * E'_W = 0 \text{ applies.} \quad (8)$$

The primed quantities in (7) and (8) are proportional to the unprimed quantities in Figure 1. They differ from them by the coefficients for the colour-difference signals. With (5), (6), (7) and (8) and taking into account the non-linear relationship between the primary colour control signals and the tristimulus values themselves according to Figure 1, (3) can be written in the form

$$Y_2 = a_B(E_{Y2}+E'_U)^{\gamma} + a_R(E_{Y2}+E'_V)^{\gamma} + a_G(E_{Y2}+E'_W)^{\gamma} \quad (9)$$

The non-linearity of present-day colour viewing tubes is distinguished by γ values between 2.2 and 2.8. A sufficiently accurate approximation for the majority of tubes would be a mean value of $\gamma = 2.5$. This value is therefore used as a basis for the later quantitative evaluation.

It can be gathered directly from equation (9) that the luminance is only conveyed exclusively by E_{Y2} when the trivial case $E'_{U2} = E'_{V2} = E'_{W2} = 0$ is present, that is to say there is achromatic transmission, or when $\gamma = 1$. It can be shown that for $\gamma \neq 1$, the luminance of the colour picture is reduced in comparison with the achromatic picture. The present-day television

standards are based on y values which are greater than 1; they lead to an increase in the display luminance through finite chrominance signal values. This fact can also be interpreted as meaning that some of the display luminance is transmitted via the chrominance channel.

In the case of a low-pass filtering, the primary colour control signals become

$$\begin{aligned} E_{R2} &= E'_{V2L} + E_{Y2} = E_{R2L} + E_{Y2H} \\ E_{G2} &= E'_{W2L} + E_{Y2} = E_{G2L} + E_{Y2H} \\ E_{B2} &= E'_{U2L} + E_{Y2} = E_{B2L} + E_{Y2H} \end{aligned} \quad (10)$$

In (10), the low-pass filtered components are provided with the index L ("low"); the differences between the original signals and the corresponding low-pass filtered signals have the index H ("high"). As the right-hand sides of equation (10) show, a correct control of the display unit is effected only with regard to the low-pass filtered components, the "highs" are underrepresented by E_{Y2H} with finite chrominance. With high colour picture saturations, this can lead to considerable luminance distortion.

Figures 3a and 3b show, illustrated in principle, a comparison of the equivalent luminance signals of a line for the standard colour-bar test picture without and with chrominance signal filtration. The equivalent luminance signal is combined with the relative display luminance through the relationship

$$E_{Y2\text{äqu.}} = y_2^{1/y} \quad (11)$$

According to a knowledge of the invention, the compensation for luminance defects exists only in the "highs". They can therefore be compensated by signal height components which, with compatibility requirements, can only be transmitted in the luminance signal channel.

The corresponding additive component ΔE_Y is superimposed on all three control signals according to (10). ΔE_Y can be determined by equating the corresponding with the relative desired luminance in accordance with the relationship

$$Y_{Sol1} = a_B(E'_{U2L} + E_{Y2} + \Delta E_Y)^y + a_R(E'_{V2L} + E_{Y2} + \Delta E_Y)^y + a_G(E'_{W2L} + E_{Y2} + \Delta E_Y)^y \quad (12)$$

with $y = \text{gamma}$.

Equation 12 can be evaluated in various forms. It has been found that with suitable estimation of an initial value, an expansion with discontinuance after the linear term already provides a usable approximation solution. For the standard colour-bar test picture, Figure 4a indicates the basic trend of the compensation signal over a line period. Figure 4b shows the whole NTSC or PAL composite colour signal modified by E_Y . It shows that, in comparison with the uncompensated case, the total signal limits are exceeded only in the region of the dark spot signal. If a limitation to the standard signal height is provided here, the modified signal is compatible with the existing television standards.

Figures 5 and 6 show basic circuit diagrams of a colour television transmission system for generating and using the correction signal for the purpose of compensating the luminance defects, wherein, in addition to the circuit illustrated in Figure 1, a correction signal generating circuit KE or 36, 37, 38 and 39 is provided. The correction signal ΔE_Y is generated digitally (for example in the form of a computer) or in an analogue manner in accordance with equation 12 in these circuits and is added to the luminance signal in an addition circuit ("+" or 40). The correction signal can only be obtained with a known "desired

state". This is known only at the camera side.

By means of correction signals which are transmitted in the luminance channel of picture transmission systems usual today, luminance defects can be compensated which result from low-pass filtering of the chrominance signals. As a result, with regard to the display luminance, a similar effect is achieved as by a linearization of the camera/transmission/display system in such a manner that the gamma precorrection is carried out immediately in front of the cathode-ray picture tube. The precompensation method described so far can also be made compatible with the present-day standardized signal-processing and transmission technique.

In Figures 5 and 6, either signals E'_{U1} and E'_{V1} from the output of the coder matrix or, as an alternative to this (Figure 5), signals E_{R1} , E_{G1} , E_{B1} from the input of the coder matrix are fed to the correction signal generating circuit.

The obtaining of the correction signal ΔE_Y is effected

a) Approximation solution for $y = 2 \dots 3$

Estimated value:

$$E_{Ys} = E_{Y2\text{äqu.soll}} - E_{Y2\text{äqu.ist}} \quad (13)$$

Linear approximation obtained by means of ΔE_{Ys}

$$\Delta E_{Y1} = \Delta E_{Ys} + \frac{Y_{\text{soll}} - Y(E_{Ys})}{y * (E_{Y2} + \Delta E_{Ys})^{y-1}} \quad (14)$$

Improved approximation solution:

$$\Delta E_{Y2} = \Delta E_{Ys} + \frac{[Y_{\text{soll}} - Y(E_{Ys})] * 2}{y * [E_{Y2} + \Delta E_{Ys} + (E_{Y2} + \Delta E_{Ys})^{y-1}]} \quad (15)$$

or

$$\Delta E_Y^* = \Delta E_Y + \frac{[Y_{\text{soll}} - Y(E_{Ys})] * 2}{y * [E_{Y2} + \Delta E_{Ys}]^{y/2}} \quad (16)$$

b) For example iteratively from equation 12.

Successive approximation method

The value ΔE_y sought in equation 12 can be determined on the principle of the successive approximation method, during the A/D conversion. The compensation value ΔE_y is represented by an n-bit word in the form of 2's complement numbers. The individual bits of this word are checked iteratively.

Newton Method

The compensation value ΔE_y sought is determined iteratively according to the following formula.

$$\Delta E_y^{(i+1)} = \Delta E_y^{(i)} - \frac{f(\Delta E_y^{(i)})}{f'(\Delta E_y^{(i)})}$$

$\Delta E_y^{(i)}$: The ΔE_y value of the i^{th} iteration step

$$f(\Delta E_y) = a_B(E_u + E_y + \Delta E_y)^Y + a_R(E_u + E_y + \Delta E_y)^Y + a_G(E_u + E_y + \Delta E_y)^Y - Y_{\text{sol1}}$$

$$f'(\Delta E_y) = \frac{df(\Delta E_y)}{d\Delta E_y}$$

Figure 6 shows a detail of a colour television transmission system according to the invention with an arithmetic-logic unit for producing a luminance correction signal ΔE_y . The luminance signal E_{y1} and the chrominance signals $E_{u1,v1}$, which are supplied by a television camera are fed to a processing stage 35. The luminance signal E_{y2} and the chrominance signals $E_{u2,v2}$, which appear at the outputs of the processing stage 35, are fed to the transmitter. Both the input signals and the output signals of the processing stage 35 are fed to A/D converters 36 and 37 respectively. The outputs of the A/D converters 36, 37 lead to a corrective arithmetic unit 38, the output signal of which is fed, via a D/A converter 39, to an adder 40 and is added to the luminance output signal E_{y2} of the processing

stage 35. The output signal of the corrective arithmetic unit 38 represents a correction signal ΔE_y .

Figure 7 shows a basic module 12. Four signals, which are a luminance signal e_y and three chrominance signals e_{c1} , e_{c2} , e_{c3} are fed to this basic module 12. By means of adders 1, 2, 3, the luminance signal e_y is added to each chrominance signal e_{c1} , e_{c2} , e_{c3} . The output signals of the adders 1, 2, 3 are separately raised to a higher power, weighted and added. The weighting factors of the circuits 4, 5, 6 for raising to a higher power may be different; the power preferably corresponds to the gamma predistortion γ . The raising to a higher power and weighting of the individual sums can be effected by means of lock-up tables for example. A further possibility is the use of a digital arithmetic unit. The adder 7 delivers the output signal of the basic module 12.

Figure 8 shows a circuit arrangement for producing a composite chrominance component $E_w = e_{c3}$. The chrominance components $E_u = e_{c1}$, $E_v = e_{c2}$ are each fed to a weighting stage 8 or 9 respectively, of which the output signals, when added, give the composite chrominance component E_w . The chrominance component E_u is weighted with $-c1/c3$, the chrominance component E_v is weighted with $-c2/c3$. For the EBU standard, $c1 = b_B$, $c2 = b_R$ and $c3 = b_G$ results. For the FCC standard $c1 = a_B$, $c2 = a_R$, $c3 = a_G$ results.

Figure 9 shows a determination of a correction signal ΔE_{ys} by means of an approximation solution of zero order, an estimated value method. The luminance signal E_y , the chrominance components E_{u1} , E_{v1} appearing before the processing stage 35, and a chrominance component E_{w1} composed of these are fed to a first basic module 52. The luminance signal E_y and the chrominance components E_{u2} , E_{v2} appearing after the

processing stage 35, as well as a chrominance component E_{w2} composed of these two chrominance components are fed to a second basic module 51. The actual luminance signal y_{1st} appears at the output of the basic module 51; the desired luminance signal y_{soll} appears at the output of the basic module 52. The actual luminance signal y_{1st} is inverted and raised to the power of $1/\gamma$. The desired luminance signal y_{soll} is raised to the power of $1/\gamma$. Added together, the two signals provide a luminance correction value ΔE_{ys} .

Figure 10 shows a determination of a luminance correction signal ΔE_{y1} by means of an approximation solution of the first order. The module 34 corresponds to Figure 9. The luminance signal E_y and the correction signal ΔE_{ys} from Figure 9 are fed to an adder 16. The sum $E_y + \Delta E_{ys}$ is fed to a further basic module 56. Furthermore, the chrominance components E_{u2} , E_{v2} after the processing stage 35 and the chrominance signal E_{w2} composed from them, are fed to the basic module 56. The output signal $Y(\Delta E_{ys})$ of the basic module 56 is negated and fed with the output signal y_{soll} of the basic module 52 to an addition stage 19. The luminance signal $E_y + \Delta E_{ys}$ is weighted with $1/\gamma$ and raised to the power of $(1 - \gamma)$. This signal is fed to a multiplier 20. Furthermore, the output signal of the addition stage 19 is fed to the multiplier 20. The output signal of the multiplier 20 is added to the luminance correction signal ΔE_{ys} and the result is a luminance correction signal ΔE_{y1} .

Figure 11 shows a determination of a luminance correction signal ΔE_{y2} by means of an approximation solution of the second order. The corrected luminance component $E_y + \Delta E_{ys}$ of the first arithmetic unit 34 is raised to the power of $(\gamma - 1)$ and weighted, exponentiator 23, and added to itself 26. The addition 26 is then

weighted with the gamma predistortion γ , 27 and fed, with the addition 25 of the weighted output signal $Y(\Delta E_{ys})$ of the third basic module 56 and of the desired luminance value Y_{soll} , to a divider 28. The output signal $e1/e2$ of the divider 28 is added, 29, to the output signal ΔE_{ys} of the first arithmetic unit 34. The result is a correction signal ΔE_{y2} of a third arithmetic unit.

Figure 12 shows the construction of a pipeline basic module 30 such as is used, for example, for the iterative solution by the successive approximation method. The luminance signal e_{y2} , the chrominance components $e_{c1,c2,c3}$, a luminance component e_{so} of a previous processing stage and a clock pulse T are fed to a register 32. The register 32 is loaded with the clock pulse T and the information loaded by the preceding clock pulse T is read out. Thus the information is delayed by a clock pulse T . Accordingly, the outputs of the register 32 correspond to the inputs of the register 32. The luminance signal e_{y2} is fed to an adder 31 to the second input of which an iterative correction value Δ is applied. The output of the adder 31 leads to the luminance input e_y of a basic module 12. The chrominance inputs $e_{c1,c2,c3}$ of the basic module 12 are connected to the corresponding outputs of the register 32. These outputs are simultaneously outputs $A_{c1,c2,c3}$ of the pipeline module 30. The output of the basic module 12 leads, on the one hand to the output A_{1st} of the pipeline basic module 30 and also to inputs of an n -bit comparator 33. The number of inputs of the n -bit comparator 33 corresponds to the number of bits in the applied signals. Further inputs of the n -bit comparator are connected to the delayed luminance component e_{so} which, at the same time, is the output

luminance component A_{so} of the pipeline basic module 30. The n-bit comparator 33 delivers a non-inverted comparison result VA and an inverted comparison result $\overline{VA}$ as output signals of the pipeline basic module 30.

Figure 13 shows a circuit arrangement which realizes an iterative solution by the successive approximation method. The desired luminance value Y_{soll} of the first arithmetic unit (Figure 9) is fed to the input e_{so} of a first pipeline basic module 42. The luminance component E_y and the chrominance components E_{u2} , E_{v2} , as well as the composite chrominance component E_{w2} are fed to the corresponding inputs e_{y2} , $e_{c1,c2,c3}$ of the pipeline basic module 42. The iterative correction value Δ is set to zero. The non-inverting output VA of the n-bit comparator (33) is connected to the $(n-1)^{th}$ input D_{n-1} of the register 41. The inverting output $\overline{VA}$ of the n-bit comparator 33 is connected to the other inputs D_n , $D_{n-2} \dots D_0$ of the n-bit register 41. The outputs Δ of the register 41 deliver the iterative correction value Δ (n-bit value) for a following pipeline basic module 43, the inputs of which are connected to the outputs of the preceding pipeline basic module 42. The inverting output $\overline{\Delta}_n$ of the first register 41 is connected to the input D_{n-2} of a following register 46; the non-inverting output Δ_n of the first register 41 is connected to the input D_n of the following register 46. The luminance and chrominance inputs of the following pipeline basic modules 44..45 are each connected to the corresponding outputs of the preceding pipeline basic modules. From the second pipeline basic module 43 on, the inputs $D_{n-m} - m$, counting from register 46, being the stage of the particular register - of the registers 46...48 are connected to the non-inverting output VA of the n-bit comparator 33. The following register

inputs $D_n, n-1 \dots 0$ are connected to the preceding register outputs $\overline{\Delta}_n, \Delta_{n,n-1} \dots n-m$ as follows: the inverted output $\overline{\Delta}_n$ is connected to the inputs D_{n-1-m} ; the non-inverted outputs $\Delta_{n,n-1} \dots n-m$ are connected to the inputs $D_{n,n-1} \dots n-m$.

With an accuracy of eight places for example, this iterative method requires eight pipeline basic modules and eight registers. The accuracy of the iteratively determined correction value found is $\pm 1/2$ bit with this method, which works in real time.

Luminance defects which result through low-pass filtering of the chrominance signals are compensated by a broadband correction signal ΔE_y , which is superimposed on the regular luminance signal E_y , by the method according to the invention explained above. The correction signal ΔE_y is formed at the transmitter side and added to the regular luminance signal E_y . The reason for this is that only at the transmitter side are the necessary signals for forming the correction signal ΔE_y present or known. In order to generate the correction signal ΔE_y , according to Figure 4 for example, the luminance signal E_y as well as the colour difference signals not low-pass filtered and the low-pass filtered colour difference signals are needed. An example of application according to the invention in the field of storing colour television signals is given below.

Figure 14 shows a known system for storing colour television signals. The transmitted colour television signals are split up, in a processing circuit 61, into a luminance signal E_y and chrominance difference signals E_u, E_v . The chrominance difference signals E_u, E_v are fed, via low-pass filters 62 and 63 respectively, to a recording circuit 64 where they are prepared in a suitable form. The luminance signal E_y is likewise fed to the recording

circuit 64. The output signal of the recording circuit 64 is recorded on a storage medium 65, for example magnetic tape or video disc, and during reproduction is processed in a following reproduction circuit 66 for the subsequent further processing stage 67.

Figure 15 shows an embodiment of the invention in an arrangement for storing colour television signals which, in addition to the circuit elements given in Figure 14, contains a circuit 68 for producing a correction signal ΔE_{yw} . In order to produce the correction signal ΔE_{yw} , the chrominance signals E_u , E_v and the luminance signal E_y from the processing circuit 61 as well as the output signals of the low-pass filters 62, 63 are fed to the circuit 68. The correction signal ΔE_{yw} produced is added to the luminance signal E_y in an addition circuit 70 and the signal thus obtained is fed to the recording circuit 64.

In the existing colour television systems, the non-linear transmission characteristic of the picture tube is compensated already during the filming; in this case it is a question of the so-called gamma predistortion. Because of this predistortion, luminance information is also transmitted in the chrominance difference signals E_u , E_v .

During the storage of colour television signals, the colour television signal is first split up, in the processing circuit 61, into a luminance signal E_y and two chrominance difference signals E_u , E_v . Since the human sense of sight is considerably more insensitive to chrominance-modulated structures than to luminance-modulated structures, the chrominance difference signals E_u , E_v are low-pass filtered in order to save storage space. This is done during use at home after reception, that is to say at the display side. Because of the low-pass filtering 62, 63 of the chrominance difference signals E_u , E_v , the display luminance E_y is additionally

influenced. This influencing is compensated by the correction signal ΔE_{yw} which is generated exclusively at the display side. The correction signal ΔE_{yw} is produced in the correction circuit 68 from the luminance signal E_y , the low-pass filtered and the non-low-pass filtered chrominance difference signals U_{uL} , E_{vL} , E_u , E_v . The influencing of the display luminance E_y is compensated by addition of the correction signal ΔE_{yw} to the display luminance E_y .

In the case of non-low-pass filtered chrominance difference signals E_u , E_v , on the assumption of the so-called colour difference signals

$$E'_u = E_B - E_y \quad E'_v = E_R - E_y \quad E'_w = E_G - E_y$$

in which the signals E'_u , E'_v and E'_w differ from the signals E_u , E_v and E_w by the corresponding coefficients:

$$Y_{soll} = a_R(E'_v + E_y)^{\gamma_R} + a_G(E'_w - E_y)^{\gamma_G} + a_B(E'_u - E_y)^{\gamma_B}$$

applies for the desired luminance Y_{soll} .

Because of the low-pass filtering, however, the filtered chrominance difference signals E_{uL} , E_{vL} are present and therefore:

$$Y_{ist} = a_R(E_{vL} + E_y)^{\gamma_R} + a_G(E_{wL} + E_y)^{\gamma_G} + a_B(E_{uL} + E_y)^{\gamma_B}$$

applies for the actual luminance, wherein the quantities provided with an "L" are intended to represent the

low-pass filtered chrominance signals. The factors a_R , a_G and a_B represent the corresponding coefficients for determining the luminance from the colour stimulus specifications of the picture tube. Particularly at places where the chrominance changes, these two luminances Y_{ist} , Y_{soll} are not the same. The correction component

E_{yw} is therefore added to the luminance signal E_y to correct the error which occurs. Thus:

$$Y_{istkomp} = a_R(E_{vL} + E_y + \Delta E_{yw})^{\gamma_R} + a_G(E_{wL} + E_y + \Delta E_{yw})^{\gamma_G} + a_B(E_{uL} + E_y + \Delta E_{yw})^{\gamma_B}$$

results for the actual luminance.

The determination of the compensation component can be determined

1) iteratively from the relationship

$$Y_{istkomp} = Y_{soll}$$

or

2) be effected by an approximation solution according to

2.1)

$$E_{yw s1} = (Y_{soll})^{1/\gamma} - (Y_{ist})^{1/\gamma}$$

2.2)

$$\Delta E_{yw s2} = \Delta E_{yw s1} + \frac{Y_{soll} - Y_{istkomp}(E_y + \Delta E_{yw s1})}{\gamma * (E_y + \Delta E_{yw s1})^{\gamma-1}}$$

2.3)

$$\Delta E_{yw s3} = E_{yw s1} + \frac{2 * Y_{soll} - Y_{istkomp}(E_y + \Delta E_{yw s1})}{\gamma * \left\{ (E_y + E_{yw s1} + (E_y + \Delta E_{yw s1})^{\gamma-1}) \right\}}$$



Claims

1. A colour television transmission system for transmitting and receiving luminance signals and low-pass filtered chrominance signals, characterised in that, in order to avoid luminance defects during the reproduction, before the transmission over a band-limited channel, a correction signal ($\Delta E_y; \Delta E_{yw}$), which is obtained from signal height components and which is produced on the one hand from input signals (E_{R1}, E_{G1}, E_{B1}) or output signals (E_{y1}, E'_{U1}, E'_{V1}) of a coder matrix (C) and low-pass filtered chrominance signals (E'_{U1L}, E'_{V1L}) or on the other hand from the luminance signals ($E_y; E_{y1}, y_2$) and chrominance signals ($E_{u1}, v_1, u_2, v_2; E_u, v, u_L, v_L$) delivered by the camera system before and after a processing stage (35; 62, 63), is added, by means of a signal processing circuit (KE, 38, 68), to all three control signals of the luminance signal (Y_{soll}) to be transmitted.

2. A colour television transmission system according to Claim 1, characterised in that the total luminance signal (Y_{soll}) satisfies the formula

$$Y_{soll} = a_B(E'_{U2L} + E_{Y2} + \Delta E_Y)^Y + a_R(E'_{V2L} + E_{Y2} + \Delta E_Y)^Y + a_G(E'_{W2L} + E_{Y2} + \Delta E_Y)^Y$$

3. A colour television transmission system according to Claim 1 and/or Claim 2, characterised in that the signal processing circuit (KE, 38, 68) is a corrective arithmetic unit (38), that the luminance signal (E_Y) and chrominance signals (E_u, v) delivered by the camera system are digitalized before and after a processing stage (35) and supplied to the corrective arithmetic unit (38) and that the correction signal determined by the arithmetic unit (38) is added (40) to the luminance signal transmitted.



4. A colour television transmission system according to Claim 3, characterised in that the arithmetic unit (38) contains one or more basic modules (12, 51, 52, 56).

5. A colour television transmission system according to claim 4, characterised in that, in the basic module (12, 51, 52, 56), the luminance signal (e_y) is added (1, 2, 3) to each of three chrominance components (e_{c1} , e_{c2} , e_{c3}).

6. A colour television transmission system according to Claim 5, characterised in that each sum is raised to a higher power and weighted (4, 5, 6).

7. A colour television transmission system according to Claim 6, characterised in that these sums raised to a higher power and weighted are added (7).

8. A colour television transmission system according to Claim 3, characterised in that the arithmetic unit (38) comprises one or more circuit arrangements (Figure 8, 49, 50) for producing a composite chrominance component (E_w , e_{c3}).

9. A colour television transmission system according to Claim 8, characterised in that a composite chrominance component ($e_{c3} = E_w$) is produced from the chrominance components ($e_{c1} = E_u$, $e_{c2} = E_v$) (Figure 8).

10. A colour television transmission system according to Claim 9, characterised in that, in order to produce the further chrominance component (e_{c3}), the chrominance components (e_{c1} , e_{c2}) are differently weighted (8, 9) and added (10).

11. A colour television transmission system according to any one or more of the preceding Claims 3 to 10,



characterised in that the luminance component (E_y) together with the two chrominance components (E_{u1} , E_{v1}) which were branched off before the processing stage, and a chrominance component (E_{w1}) composed therefrom, is supplied to a first basic module (52), the output signal of which represents a desired luminance value (y_{soll}).

12. A colour television transmission system according to Claim 11, characterised in that the luminance component (E_y), together with the two chrominance components (E_{u2} , E_{v2}) which were branched off after the processing stage and a chrominance component (E_{w2}) composed therefrom, is supplied to a second basic module (51), the output signal of which represents an actual luminance value (y_{ist}).

13. A colour television transmission system according to Claim 12, characterised in that the output signals of the two basic modules (51, 52) are raised to a higher power, weighted (53, 54) and supplied to an addition stage (55), the output signal (ΔE_{ys}) of which is the output signal of a first arithmetic unit (34) (Figure 9).

14. A colour television transmission system according to Claim 13, characterised in that a corrected luminance component ($E_y + \Delta E_{ys}$), which consists of the sum of the output signal (ΔE_{ys}) of the first arithmetic unit (34) and the luminance component (E_y), is supplied to a third basic module (56), that the chrominance components (E_{u2} , E_{v2}) which are branched off after the processing stage (35), and the chrominance component (E_{w2}) composed therefrom are supplied to the third basic module (56), and that the output signal ($y(\Delta E_{ys})$) of the third basic module (56) is negated ($18, -y(\Delta E_{ys})$).



15. A colour television transmission system according to Claim 14, characterised in that the output signal of the first basic module (52) is added (19) to the negated output signal ($-y(\Delta E_{ys})$) of the third basic module (56) and multiplied (20) by the corrected luminance component ($E_y + \Delta E_{ys}$) of the first arithmetic unit (34), which has been raised to a higher power and weighted (17), that the output signal of the multiplier (20) and the output signal (ΔE_{ys}) of the first arithmetic unit (34) are supplied to an adder (21), the output signal of which represents the correction signal (ΔE_{y1}) of a second arithmetic unit (Figure 10).

16. A colour television transmission system according to Claim 14, characterised in that the corrected luminance component ($E_y + \Delta E_{ys}$) of the first arithmetic unit (34), raised to a higher power and weighted (23), is added to itself (26), that the sum is weighted (27) and supplied, together with the sum (25) of the weighted output signal ($y(\Delta E_{ys})$) of the third basic module (56) and of the desired luminance value (Y_{soll}), to a divider (28), of which the output signal ($e1/e2$) added (29) to the output signal (ΔE_{ys}) of the first arithmetic unit (34) forms a correction signal (ΔE_{y2}) of a third arithmetic unit (Figure 11).

17. A colour television transmission system according to any one or more of Claims 3 to 16, characterised in that a pipeline basic module (30) comprises a register (32), an n-bit comparator (33), a basic module (12) and an adder (31) (Figure 12).

18. A colour television transmission system according to Claim 17, characterised in that the luminance component (e_{y2}), the chrominance components



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($e_{c1,2}$), the composite chrominance component (e_{c3}), a luminance component (e_{so}) from a previous processing stage (12) and a clock pulse (T) are supplied to the register (32).

19. A colour television transmission system according to Claim 18, characterised in that an output signal (A_{y2}), which corresponds to the luminance component (e_{y2}) of the register (32), on the one hand is an output signal (A_{y2}) of the luminance component of the pipeline basic module (30), and on the other hand is added to an iterative correction value (Δ) determined from the preceding stage to form an iteratively corrected luminance component (e_{yA}).

20. A colour television transmission system according to Claim 18 or 19, characterised in that the output signals ($A_{c1,c2,c3}$) of the pipeline basic module (30), which correspond to the chrominance components ($e_{c1,c2}$) and the composite chrominance component (e_{c3}), are supplied together with the iteratively corrected luminance component (e_{yA}) to a basic module (12), the output signal of which represents an iterative actual luminance value (A_{ist}).

21. A colour television transmission system according to Claim 20, characterised in that the output signal (A_{so}) of the register (32), which corresponds to the desired luminance value (e_{so}), on the one hand is an output signal (A_{so}) of the pipeline basic module (30) and on the other hand is supplied, together with the iterative actual luminance value (A_{ist}), to an n-bit comparator (33).

22. A colour television transmission system according to Claim 21, characterised in that the n-bit



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comparator has two one-bit logic outputs ($VA, \overline{VA}$) which are inverted in relation to one another.

23. A colour television transmission system according to Claims 11 and 22, characterised in that a fourth arithmetic unit (Figure 13) has the following construction:

the desired luminance value (y_{soll}) is supplied to the input of a first pipeline basic module (42),

the luminance component (E_y) and the chrominance components (E_{u2}, E_{v2}) as well as the composite chrominance component (E_{w2}) are supplied to the corresponding inputs of the pipeline basic module (42),

the iterative correction value (Δ) is set to zero,

the non-inverting output (VA) of the n-bit comparator (33) is connected to the (n-1)th input (D_{n-1}) of the register (41),

the inverting output ($\overline{VA}$) of the n-bit comparator (33) is connected to the other inputs ($D_n, D_{n-2} \dots D_0$) of the n-bit register (41),

an output (Δ) of the register (41) delivers an iterative correction value (Δ) for a following pipeline basic module (43), the inputs ($e_{y2}, e_{c1, c2, c3, so}$) of which are connected to the outputs of the preceding pipeline basic module (42),

the outputs of the first register (41) are connected to the inputs of a following register (46),

and there are as many stages present as the accuracy of the iterative correction value (Δ) requires.

24. A colour television transmission system according to any one or more of Claims 1 to 23, characterised in that the transmission is effected on a storage medium.