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(54) Method and device for coding video levels in a plasma display panel

(57) The invention relates to a method and a device for coding video levels of pixels of a colour component of a picture to be displayed on a display device into code words. The invention is more particularly applicable to Plasma Display Panels (PDP) to improve the picture quality (grayscale enhancement, dynamic false contour reduction). The main idea of the invention is to automatically change the floor and ceiling levels used classically for dithering each pixel value depending on the neighboring pixels of the same color component. The size of the window determining the neighboring pixels is dependent on the definition of the wanted flat field size.

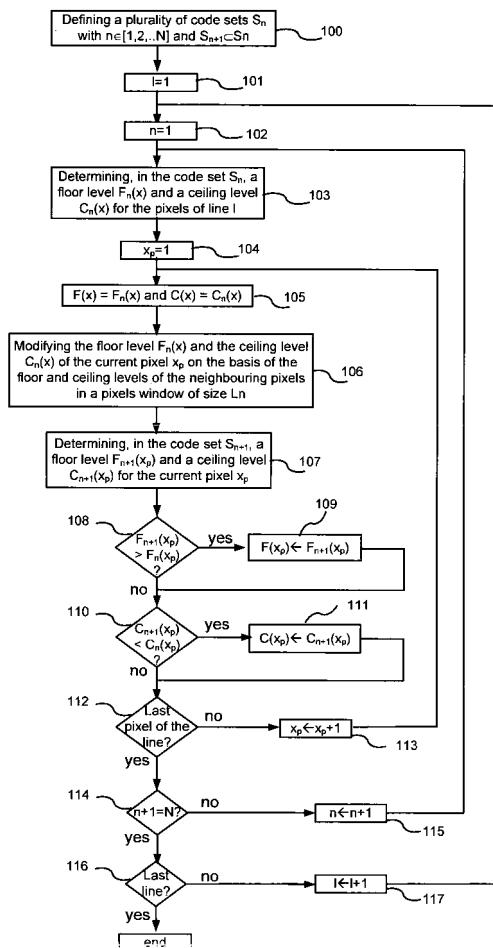


FIG.8

Description

[0001] The invention relates to a method and a device for coding video levels of pixels of a colour component of a picture to be displayed on a display device into code words. The invention is more particularly applicable to Plasma Display Panels (PDP) to improve the picture quality (grayscale enhancement, dynamic false contour reduction).

Background

[0002] Though they are known for many years, plasma display panels are encountering a growing interest from TV manufacturers. Indeed, this technology now makes it possible to achieve flat color panel of large size (out of the CRT limitations) and with very limited depth without any viewing angle constraints. Referring to the last generation of European TV, a lot of work has been made to improve its picture quality. Consequently, a new technology like the plasma one has to provide a picture quality as good as or better than the old standard TV technology.

[0003] On the one hand, the Plasma technology gives the possibility of "unlimited" screen size, of attractive thickness, but on the other hand, it generates new kinds of artifacts, which could reduce the picture quality. Most of these artifacts are different than those of CRT screen and so more visible since people are used to seeing old TV artifacts unconsciously. One of these artifacts called "dynamic false contour effect" is described in detail hereinafter. Generally, a Plasma Display Panel (PDP) utilizes a matrix array of discharge cells, which could only be "ON" or "OFF". Therefore, unlike a CRT or LCD in which grey levels are expressed by analogue control of the light emission, a PDP controls grey level by a Pulse Width Modulation (PWM) of each cell. This time-modulation is integrated by the eye over a period corresponding to the eye time response. The more often a cell is switched on in a given time frame, the higher is its luminance (brightness).

[0004] For example, when disposing of 8 bit luminance levels (256 levels per colour, so 16.7 million colours), each level can be represented by a combination of the 8 following bits:

25 1-2-4-8-16-32-64-128

[0005] To realize such a coding, the frame period can be divided in 8 lighting sub-periods (called sub-fields), each corresponding to a bit and a brightness level. The number of light pulses for the bit "2" is the double as for the bit "1" etc. With these 8 sub-periods, it is possible through combination to build the 256 grey levels. The eye of an observer integrates over a frame period these sub-periods to catch the impression of the right grey level. Figure 1 presents this decomposition.

[0006] The light emission pattern introduces new categories of image-quality degradation corresponding to disturbances of grey levels and colours. These are defined as "dynamic false contour effect" since they correspond to disturbances of grey levels and colours in the form of an apparition of coloured edges in the picture when an observation point on the plasma panel moves. Such failures on a picture lead to the impression of strong contours appearing on homogeneous areas. The degradation is enhanced when the image has a smooth gradation (like skin) and when the light-emission period exceeds several milliseconds.

[0007] When an observation point (eye focus area) on the PDP screen moves, the eye follows this movement. Consequently, it does no more integrate the same cell over a frame (static integration) but it integrates information coming from different cells located on the movement trajectory and it mixes all these light pulses together, which leads to a faulty signal information.

[0008] Basically, the false contour effect occurs when there is a transition from one level to another with a totally different code. So the first point is to select, from a code (with n sub-fields) which permits to achieve p grey levels (typically $p=256$), m grey levels (with $m < p$) among the 2^n possible sub-fields arrangements (when working at the encoding) or among the p grey levels (when working at the video level) so that close levels have close sub-fields arrangements.

[0009] The second point is to keep a maximum of levels in order to keep a good video quality. To this end the minimum of chosen levels should be equal to twice the number of subfields. For all further examples, a 11 sub-fields mode defined as following is used:

50 1 2 3 5 8 12 18 27 41 58 80.

[0010] For these issues the Gravity Centre Coding (GCC) was introduced in document EP 1 256 924. The content of this document is expressively incorporated by reference herewith.

[0011] As seen previously, the human eye integrates the light emitted by Pulse Width Modulation. So if one considers all video levels encoded with a basic code, the time position of these video levels (the centre of gravity of the light) is not growing continuously with the video level as shown in Figure 2.

[0012] The centre of gravity CG2 for a video level 2 is larger than the centre of gravity CG1 of video level 1 and the centre of gravity CG3 of video level 3 is smaller than that of video level 2.

[0013] This introduces false contour. The centre of gravity is defined as the centre of gravity of the subfields 'on' weighted by their sustain weight:

$$CG(\text{code}) = \frac{\sum_{i=1}^n sfW_i * \delta_i(\text{code}) * sfCG_i}{\sum_{i=1}^n sfW_i * \delta_i(\text{code})}$$

10

where sfW_i is the subfield weight of i^{th} subfield, δ_i is equal to 1 if the i^{th} subfield is 'on' for the chosen code, 0 otherwise and $SfCG_i$ is the centre of gravity of the i^{th} subfield, i.e. its time position, as shown in Figure 3 for the first seven sub-fields.

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[0014] The temporal centres of gravity of the 256 video levels for the 11 subfields code chosen here can be represented as shown in Figure 4.

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[0015] The curve is not monotonous and presents a lot of jumps. These jumps correspond to false contour. According to GCC, these jumps are suppressed by selecting only some levels, for which the gravity centre grows continuously with the video levels apart from exceptions in the low video level range up to a first predefined limit and/or in the high video level range from a second predefined limit on. This can be done by tracing a monotone curve without jumps on the previous graphic, and selecting the nearest point as shown in Figure 5. Thus, not all possible video levels are used when employing GCC.

25

[0016] In the low video level region it should be avoided to select only levels with growing gravity centre because the number of possible levels is low and so if only growing gravity centre levels were selected, there would not be enough levels to have a good video quality in the black levels since the human eye is very sensitive in the black levels. In addition the false contour in dark areas is negligible.

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[0017] In the high level region, there is a decrease of the gravity centres. So there is a decrease also in the chosen levels, but it is not important since the human eye is not sensitive in the high level. In these areas, the eye is not capable to distinguish different levels and the false contour level is negligible regarding the video level (the eye is only sensitive to relative amplitude if the Weber-Fechner law is considered). For these reasons, the monotony of the curve is necessary just for the video levels between 10% and 80% of the maximal video level.

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[0018] In this case, for this example, 38 levels ($m=38$) are selected among the 256 possible. These 38 levels permit to keep a good video quality (grey-scale portrayal).

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[0019] On one hand, the GCC concept enables a visible reduction of the false contour effect. On the other hand, it introduces noise in the picture in the form of dithering needed since less levels are available than required. The missing levels are then rendered by means of spatial and temporal mixing of available GCC levels. The false contour effect is an artefact that only appears on specific sequences (mostly visible on large skin area) whereas the introduced noise is visible all the time and can give an impression of noisy display. For that reason, it is important to use the GCC method only if there is a risk of false contour artefacts.

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[0020] Document EP 1 376 521 introduces a solution for this based on a motion detection enabling to switch ON or OFF the GCC depending on whether there is or not a lot of motion in the picture.

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[0021] Document EP 1 522 964 discloses also a method for processing video pictures wherein each video picture is divided into areas of at least two types according to the video gradient of the picture. A specific video gradient range is allocated to each type of area. For each type of area, a specific code reducing false contour effects is used to encode the pixel of this area. For example, areas of a first type are encoded with a classical coding (255 video levels) and areas of a second type are encoded with a GCC coding (40 video levels).

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[0022] As shown, the most effective solution to reduce or to eliminate dynamic false contour is to sacrifice the gray level quality, i.e. to choose a carefully selected smaller code set and use dithering to obtain all the wanted video levels, as for the GCC coding. But since the coding operation and the dithering operation are carried out independently, dithering noise is not optimized.

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Invention

[0023] The invention proposes a new coding method enabling to select the best coding scheme in terms of noise and dynamic false contour for every area of the picture.

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[0024] The main idea of the invention is to automatically change floor and ceiling levels used classically for dithering each pixel value depending on the neighboring pixels of the same color component. The size of the window determining the number of neighboring pixels is dependent on the definition of the wanted flat field size.

[0025] According to the invention, this object is solved by the method described in the appended claims.

[0026] More particularly, the invention concerns a method for coding video levels of pixels of a colour component of a picture to be displayed on a display device into a code word belonging to at least a first code set and/or a second code set, the second code set being a subset of the first code set, comprising the following steps:

- 5 - determining, for each pixel of the picture, at least a first floor level and a first ceiling level that can be coded by a code word of the first code set and a second floor level and a second ceiling level that can be coded by a code word of the second code set, the first and second floor levels being respectively the highest video level among the video levels corresponding to the code words of the first and second code sets equal to or lower than the video level of the considered pixel and the first and second ceiling levels being respectively the lowest video level among the video levels corresponding to the code words of the first and second code sets equal to or higher than the video level of the considered pixel,
- 10 - determining, for each current pixel, a floor level and ceiling level on the basis of the first floor level and first ceiling level of said current pixel and the first floor levels and first ceiling levels of a predetermined number neighbouring pixels belonging to a window including the current pixel,
- 15 - substituting, for each current pixel, the floor level by the second floor level if the said floor level is lower than the second floor level and the ceiling level by the second ceiling level if said ceiling level is lower than the second ceiling level, and
- 20 - selecting, for each current pixel, the code word among the code word of the floor level and the code word of the new ceiling level for coding the video level of the current pixel.

[0027] It further comprises a step for encoding, for each current pixel, the selected code word into a subfield code word, wherein to each bit of the subfield code word a certain duration is assigned, hereinafter called sub-field, during which a pixel can be activated for light generation.

[0028] Preferably, the code words of the second code set are selected among the code words of the first code set according to the rule that the temporal centre of gravity for the light generation of the corresponding sub-field code words grows continuously with the video level of said code words apart from exceptions in the low video level range up to a first predetermined limit and/or for in the high video level range from a second predetermined limit on.

[0029] In a specific embodiment, the step for determining the floor level of the current pixel comprises the step of allocating the first floor level of the current pixel to the floor level and the step of substituting said floor level of the current pixel by the highest first ceiling level in the window and the step for determining the ceiling level of the current pixel comprises the step of allocating the first ceiling level of the current pixel to the ceiling level and the step of substituting said ceiling level of the current pixel by the lowest first floor level in the window.

[0030] Otherwise, the step of selecting the code word of the current pixel among the code word of the floor level and the code word of the ceiling level) comprises the following steps:

- 35 - computing a coefficient α such that $I(x) = \alpha \cdot c(x) + (1-\alpha) \cdot f(x)$ where
 - $I(x)$ is the video level of the current pixel x ,
 - $c(x)$ is the new ceiling level of the current pixel, and
 - $f(x)$ is the new floor level of the current pixel,
- 40 - generating a random number N_{md} such that $0 \leq N_{md} \leq 1$,
- selecting the ceiling level if the coefficient α is greater than or equal to N_{md} and selecting the floor level if the coefficient α is lower than the random number N_{rnd} .

[0031] The invention concerns also a device for coding video levels of pixels of a colour component of a picture to be displayed on a display device into a code word belonging to at least a first code set and/or a second code set, the second code set being a subset of the first code set. The device comprises :

- 50 - means for determining, for each pixel of the picture, at least a first floor level and a first ceiling level that can be coded by a code word of the first code set and a second floor level and a second ceiling level that can be coded by a code word of the second code set, the first and second floor levels being respectively the highest video level among the video levels corresponding to the code words of the first and second code sets equal to or lower than the video level of the considered pixel and the first and second ceiling levels being respectively the lowest video level among the video levels corresponding to the code words of the first and second code sets equal to or higher than the video level of the considered pixel,
- 55 - means for determining, for each current pixel, a floor level and ceiling level on the basis of the first floor level and first ceiling level of said current pixel and the first floor levels and first ceiling levels of a predetermined number

neighbouring pixels belonging to a window including the current pixel,

- means for substituting, for each current pixel, the floor level by the second floor level if the said floor level is lower than the second floor level and the ceiling level by the second ceiling level if said ceiling level is lower than the second ceiling level, and
- 5 - dithering means for selecting, for each current pixel, the code word among the code word of the floor level and the code word of the new ceiling level for coding the video level of the current pixel.

Brief description of the drawings

10 [0032] Exemplary embodiments of the invention are illustrated in the drawings and in more detail in the following description. The drawings showing in:

Fig. 1 the composition of a frame period for the binary code;

15 Fig. 2 the centre of gravity of three video levels;

Fig. 3 the centre of gravity of sub-fields;

20 Fig. 4 the temporal gravity centre depending on the video level;

Fig. 5 chosen video levels for GCC;

25 Fig.6 a picture representing a woman holding a glass wherein false contour effect is present on the skin areas of the woman;

Fig.7 three regions in the picture of fig.6;

Fig.8 a flow chart of the adaptive coding method according to the invention

30 Fig.9 a code space (or set) organization;

Fig.10 a block diagram of a plasma display panel implementing the adaptive coding of the invention;

Fig.11 a block diagram of an adaptive coder according to the invention;

35 Fig.12 a block diagram of an extended coder of the adaptive coder of fig.11;

Fig.13 a block diagram of dithering means of the plasma display panel of Fig.10, and

40 Fig. 14 a hardware-suitable block description of the dithering means.

DESCRIPTION OF PREFERRED EMBODIMENTS

45 [0033] Figure 6 shows a picture representing a woman holding a glass wherein false contour effect is present on the skin areas of the woman.

[0034] As can be seen in Figure 7, the picture of figure 6 can be divided in regions of different types. For example, in region 1 corresponding to a flat field, there is almost no noticeable change in the video level and the area is relatively big. Such a region usually does not suffer from dynamic false contour and can be coded with the maximum number of video levels available. On the other hand, a region with a smooth and gradual variation in the video level between the neighboring pixels, such as region 2, is more suitable to be coded with a code set that is optimized for such a case, for example a gravity center coding GCC as defined before. Finally, for region 3, where the transitions are sharper, it is best coded with a smaller carefully selected code set than that used in region 2. Of course by other criterion it is possible to define more than three regions to even improve the picture quality.

[0035] The invention is mainly a method to decide the best code available for each region in a general way regardless of the code set numbers. The main idea of the invention is to automatically change the floor and ceiling levels used for dithering each pixel value depending on the neighboring pixels of the same color component. Floor and ceiling values are defined at a later point in the specification. The size of the window determining the neighboring pixels to be taken for the decision is dependent on the definition of the wanted flat field size.

[0036] The inventive method is applied to the video signal of a picture after being received and after the application of a gamma rescaling function (also called de-gamma function) on it.

[0037] A flow chart of the inventive method is shown at figure 8. At a first step 100, a plurality of code sets S_n are defined with $n \in [1, 2, \dots, N]$ and with $S_{n+1} \subset S_n$. For example, three code sets S_1 , S_2 and S_3 are defined as shown in Figure 9. The code set S_1 comprises for example 255 code words for coding the 255 video levels of a 8 bit video input. The code words are for example those given in Annex. The weights of the sub-fields associated to these codes are 1 2 3 5 8 12 18 27 41 58 80. The use of this code set in a region of the picture guarantees the best video quality for this region. It is used for regions having no video level variations over a relatively large area, typically regions like region 1. The code set S_2 is a subset of S_1 . The code words of the code set S_2 are for example selected among the code words of the first code set according to the rule that the temporal centre of gravity for the light generation of the corresponding sub-field code words grows continuously with the video level of said code words apart from exceptions in the low video level range up to a first predetermined limit and/or for in the high video level range from a second predetermined limit on. Such code words are for example the GCC code words given for the code set S_2 in the table given of the annex. In this example, S_2 comprises 38 code words. The code words of S_2 are used for coding regions like region 2 where the video levels vary smoothly and gradually. Finally, the code set S_3 is a subset of the code set S_2 . An example of code set S_3 is also given in table of the annex. It comprises 11 code words. The code words of S_3 are used for coding regions like region 3 where the video level transitions are sharp. It is possible to define other code sets S_n . The only limitation is that the last code set can not be smaller in size than the number of subfields used in the driving scheme.

[0038] At steps 101 and 102, the parameter l of line and the parameter n are reinitialized.

[0039] In the following steps, floor levels and ceiling levels are defined to find the best code word to use. The floor level $F_n(x)$ for a pixel at a position x in a code set S_n is the highest video level among the video levels corresponding to the code words of the code set S_n equal to or lower than the video level of the pixel at the position x . For simplicity reasons, the pixel x will designate the pixel at the position x in the following specification. The ceiling level $C_n(x)$ for a pixel x in a code set S_n is the lowest video level among the video levels corresponding to the code words of the code set S_n equal to or higher than the video level of the pixel x . For example, if the video level of the pixel x is 145.9 and if the code sets of the annex table are used, we have:

$$F_1(x) = 145 \text{ and } C_1(x) = 146$$

$$F_2(x) = 134 \text{ and } C_2(x) = 148$$

$$F_3(x) = 105 \text{ and } C_3(x) = 163$$

[0040] At the next step 103, a floor level $F_1(x)$ and a ceiling level $C_1(x)$ are determined in the code set S_1 for the line l of pixels. We obtain for example for 9 consecutive pixels, the table 1 :

Table 1

Ceiling level $C_1(x)$	132	146	145	149	146	161	159	160	157
Current video level	131.2	145.3	144.6	148.9	145.9	160.1	158.7	159.3	156.6
Floor level $F_1(x)$	131	145	144	148	145	160	158	159	156

[0041] Then, the pixels are processed one by one successively. The current pixel x_p is reinitialized at step 104. The floor level and the ceiling level, $F_1(x_p)$ and $C_1(x_p)$, are first taken as floor level and the ceiling level $F(x_p)$ and $C(x_p)$ of the current pixel x_p at step 105. The levels $F(x_p)$ and $C(x_p)$ of the current pixel x_p are then modified at step 106 on the basis of the floor and ceiling levels $F_1(x)$ and $C_1(x)$ of a number of neighbouring pixels, for example as following :

$$F(x_p) = \min (F_1(x_p), C_1[x_{p-L/2}, x_{p+L/2}])$$

$$C(x_p) = \max (C_1(x_p), f_1[x_{p-L/2}, x_{p+L/2}])$$

5 where:

- $F(X_p)$ and $C(X_p)$ are the modified floor and ceiling levels for the current pixel x_p ;
- $F_n(x_p)$ and $C_n(x_p)$ are the floor and ceiling levels of the current pixel x_p ;
- $\min(a,b)$ gives the minimum of the two values a or b as the output of the function;
- $\max(a,b)$ gives the maximum of the two values a or b as the output of the function; and
- $C_n[X_a, X_b]$ and $f_n[X_a, X_b]$ designate respectively the ceiling, and floor levels in the set S_n of all the pixels x between the two pixels X_a and X_b ; and
- L_{n+1} is the size of the window defining the local working area of the present method in the set S_n and including the current pixel and L neighbouring pixels.

15 [0042] The step 106 is illustrated by the following table 2. The fifth pixel is the current pixel x_p and the levels corresponding to it are shown in bold characters. The window size is equal to 9 pixels. The result is $F(x_p) = 132$ and $C(x_p) = 160$:

Table 2

Ceiling level	132	146	145	149	160	161	159	160	157
Current video level	131.2	145.3	144.6	148.9	145.9	160.1	158.7	159.3	156.6
Floor level	131	145	144	148	132	160	158	159	156

25 [0043] At step 107, the floor level $F_2(x_p)$ and the ceiling level $C_2(x_p)$ of the current pixel x_p are determined in the code set S_2 : $F_2(x_p) = 134$ and $C_2(x_p) = 148$.

[0044] At steps 108 and 109, $F_2(x_p)$ is compared to $F(x_p)$ and $C_2(x_p)$ is compared to $C(x_p)$. If $F_2(x_p) > F(x_p)$ then $F_2(x_p)$ becomes $F(x_p)$ and at steps 110 and 111, if $C_2(x_p) < C(x_p)$ then $C_2(x_p)$ becomes $C(x_p)$.

30 [0045] In a general manner, after performing the modification of the floor and ceiling of the video levels in the code set S_n , a comparison between the modified floor and ceiling levels $F(x)$ and $C(x)$ and the nominal Floor and ceiling $F_{n+1}(x)$ and $C_{n+1}(x)$ levels in the next code set (i.e. a smaller code set) for the same original video signal. If the modified floor value is smaller than the nominal value in the next code set, then the floor value is raised to the one in the next code set. The same idea is applied to the ceiling level with the difference that the smaller value in the next code set is selected.

35 [0046] In the previous example, we obtain for the fifth pixel:

Table 4

Ceiling level	132	146	145	149	149	161	159	160	157
Current video level	131.2	145.3	144.6	148.9	145.9	160.1	158.7	159.3	156.6
Floor level	131	145	144	148	135	160	158	159	156

45 [0047] All the pixels of the line I are thus processed until the last pixel of the line (steps 112 and 113). After applying this algorithm for the first time, for example with window size $L=9$ as illustrated, the decision is taken between the code set S_1 and the second code set S_2 . Areas of flat levels (almost no change in video level) tend to have similar ceiling and floor levels while those areas showing a gradient or changes in the video levels are adapted to suitable levels from the second code set.

50 [0048] At steps 114 and 115, the parameter n is incremented if n is not equal to N which is the number n associated to the smallest code set ($N=3$ in the example given here). The steps 103 to 113 are then applied again for the new parameter n , preferably with a smaller window size, for example $L=6$. In the present case, the steps 103 to 113 with $n=2$. Since $n+1=N=3$, the steps 103 to 113 are made once. The line I is then incremented until the last pixel of the picture at steps 116 and 117.

55 Description of the device implementation

[0049] The input R, G, B color channels of the colored picture are forwarded to the Gamma look up table (LUT) 210. The role of this LUT is to generate artificial gamma function to adjust the input video levels to achieve a display

behavior suitable for the display used (a PDP for this case, for example). This is used because the transmitter stations are taking into account the CRT gamma behavior. The output as 10 bits is introduced as the input to an adaptive coder block 220, which is fed by a predetermined and optimized code sets (S_1 , S_2 and S_3). The output of the adaptive coder 220 is the decided floor and ceiling levels $F(x)$ and $C(x)$ to be given to a dithering block 230 to portray the original color level. The output of the dithering block feed a classical subfield encoder 250, in the form of a coding LUT, and the output of this subfield encoder are the subfield data used to drive the screen. A random generator 240 is connected to the dithering block 230 to provide it a random number. This implementation is illustrated by the block diagram of Fig.10.

The Adaptive coder:

[0050] In the adaptive coder block 220, the input signal after being gamma corrected from look up table (LUT) values is used to decide the ceiling and the floor levels $F(x)$ and $C(x)$ for the dithering block. The block itself contains one or more extended coder blocks, as shown in Fig. 11. In the example of Fig.11, the coder block 220 comprises a ceiling and floor level generator 221 for generating nominal ceiling and floor levels $F(x)$ and $C(x)$ (steps 103 and 105) using the code words of the code set S_1 , a first extended coder 222 using the code words of the code sets S_1 and S_2 and a second extended coder 223 using the code words of the code sets S_2 and S_3 . An extended coder block, detailed in Fig. 12, decides the ceiling and the floor levels $F(x)$ and $C(x)$ based on the input signal and the two code sets S_n and S_{n+1} . Those intermediate outputs become the inputs for the next extended coder in addition to the original signal itself. More extended coders can be added depending on the code sets selected and the extended codes are cascaded. In fig.12, the extended coder block can be divided into two blocks: a block 300 for modifying the ceiling and floor levels as indicated by step 106 of figure 8 and a block 301 for limiting the ceiling and floor levels as indicated by steps 107 to 111 of figure 8.

The dithering block:

[0051] The main role of the dithering block 230 is to portray the original video level from the available input levels. The output of the system, as shown in Fig. 13, is one of the available two inputs, the ceiling level $C(x)$ or the floor level $F(x)$ coming from the adaptive coder 220. The decision of which value should be the output is based on the following steps:

1. Decide how often should each of the two input levels be selected as the output from the following equation :

$$I(x) = \alpha \cdot C(x) + (1-\alpha) \cdot F(x)$$

where:

- $I(x)$ is the original video level to be represented.
- $C(x)$ is the ceiling level of the video level of the pixel x .
- $F(x)$ is the floor level of the video level of the pixel x .
- α is the weight factor resembling the participation of the ceiling level $C(x)$ in the original video level value $I(x)$, as a result the participation amount of the floor level $F(x)$ is, of course, $(1-\alpha)$, $(0 \leq \alpha \leq 1)$.

Directly, α can be calculated as

$$\alpha = \frac{I(x) - F(x)}{C(x) - F(x)}$$

2. Generate a normalized value output from the random generator N_{rnd} ($0 \leq N_{rnd} \leq 1$) and using α as the decision threshold, the output of the dithering block, $I_{out}(x)$, is:

$$\begin{cases} C(x) \rightarrow \alpha \geq N_{rnd} \\ F(x) \rightarrow \alpha \leq N_{rnd} \end{cases}$$

5

Hardware implementation of the dithering function

10 [0052] To implement α from the above mentioned equation, it is not favorable in the sense of hardware engineering to have a division function, the next hardware block description shows how to interpret the dithering function in a hardware favorable way which includes only comparators, multipliers, and adders/subtractors. Fig. 14 shows the block diagram of such an implementation.

ANNEX

15

[0053]

Gray level	Code word	Center of gravity	Code set S_1	Code set S_2	Code set S_3
0	0 0 0 0 0 0 0 0 0 0 0 0	0	X	X	X
1	1 0 0 0 0 0 0 0 0 0 0 0	575	X	X	X
2	0 1 0 0 0 0 0 0 0 0 0 0	1160	X	X	
3	1 1 0 0 0 0 0 0 0 0 0 0	965	X		
4	1 0 1 0 0 0 0 0 0 0 0 0	1460	X	X	X
5	0 1 1 0 0 0 0 0 0 0 0 0	1517	X	X	
6	1 1 1 0 0 0 0 0 0 0 0 0	1360	X		
7	0 1 0 1 0 0 0 0 0 0 0 0	2020	X		
8	1 1 0 1 0 0 0 0 0 0 0 0	1840	X	X	
9	1 0 1 1 0 0 0 0 0 0 0 0	1962	X	X	X
10	0 1 1 1 0 0 0 0 0 0 0 0	1941	X		
11	1 1 1 1 0 0 0 0 0 0 0 0	1816	X		
12	1 0 1 0 1 0 0 0 0 0 0 0	2486	X		
13	0 1 1 0 1 0 0 0 0 0 0 0	2429	X		
14	1 1 1 0 1 0 0 0 0 0 0 0	2297	X	X	
15	0 1 0 1 1 0 0 0 0 0 0 0	2543	X		
16	1 1 0 1 1 0 0 0 0 0 0 0	2420	X	X	
17	1 0 1 1 1 0 0 0 0 0 0 0	2450	X	X	X
18	0 1 1 1 1 0 0 0 0 0 0 0	2411	X		
19	1 1 1 1 1 0 0 0 0 0 0 0	2315	X		
20	1 1 0 1 0 1 0 0 0 0 0 0	2938	X		
21	1 0 1 1 0 1 0 0 0 0 0 0	2938	X		
22	0 1 1 1 0 1 0 0 0 0 0 0	2884	X		
23	1 1 1 1 0 1 0 0 0 0 0 0	2783	X	X	
24	1 0 1 0 1 1 0 0 0 0 0 0	3078	X		
25	0 1 1 0 1 1 0 0 0 0 0 0	3025	X		
26	1 1 1 0 1 1 0 0 0 0 0 0	2930	X	X	

(continued)

Gray level	Code word	Center of gravity	Code set S_1	Code set S_2	Code set S_3
5	27	0 1 0 1 1 1 0 0 0 0 0	3043	X	
10	28	1 1 0 1 1 1 0 0 0 0 0	2955	X	X
15	29	1 0 1 1 1 1 0 0 0 0 0	2955	X	
20	30	0 1 1 1 1 1 0 0 0 0 0	2915	X	
25	31	1 1 1 1 1 1 0 0 0 0 0	2839	X	
30	32	1 1 1 0 1 0 1 0 0 0 0	3474	X	
35	33	0 1 0 1 1 0 1 0 0 0 0	3550	X	
40	34	1 1 0 1 1 0 1 0 0 0 0	3462	X	
45	35	1 0 1 1 1 0 1 0 0 0 0	3448	X	
50	36	0 1 1 1 1 0 1 0 0 0 0	3400	X	
55	37	1 1 1 1 1 0 1 0 0 0 0	3324	X	X
60	38	1 1 0 1 1 1 1 0 0 0 0	3625	X	
65	39	1 0 1 1 1 1 1 0 0 0 0	3608	X	
70	40	0 1 1 1 0 1 1 0 0 0 0	3561	X	
75	41	1 1 1 1 0 1 1 0 0 0 0	3488	X	X
80	42	1 0 1 0 1 1 1 0 0 0 0	3640	X	
85	43	0 1 1 0 1 1 1 0 0 0 0	3596	X	
90	44	1 1 1 0 1 1 1 0 0 0 0	3527	X	X
95	45	0 1 0 1 1 1 1 0 0 0 0	3582	X	X
100	46	1 1 0 1 1 1 1 0 0 0 0	3516	X	
105	47	1 0 1 1 1 1 1 0 0 0 0	3504	X	
110	48	0 1 1 1 1 1 1 0 0 0 0	3468	X	
115	49	1 1 1 1 1 1 1 0 0 0 0	3409	X	
120	50	1 1 1 1 0 1 0 1 0 0 0	4080	X	
125	51	1 0 1 0 1 1 0 1 0 0 0	4193	X	
130	52	0 1 1 0 1 1 0 1 0 0 0	4146	X	
135	53	1 1 1 0 1 1 0 1 0 0 0	4079	X	
140	54	0 1 0 1 1 1 0 1 0 0 0	4114	X	
145	55	1 1 0 1 1 1 0 1 0 0 0	4050	X	
150	56	1 0 1 1 1 1 0 1 0 0 0	4030	X	
155	57	0 1 1 1 1 1 0 1 0 0 0	399	X	
160	58	1 1 1 1 1 1 0 1 0 0 0	3931	X	X
165	59	1 1 1 0 1 0 1 1 0 0 0	4257	X	
170	60	0 1 0 1 1 0 1 1 0 0 0	4286	X	
175	61	1 1 0 1 1 0 1 1 0 0 0	4225	X	
180	62	1 0 1 1 1 0 1 1 0 0 0	4204	X	
185	63	0 1 1 1 1 0 1 1 0 0 0	4165	X	
190	64	1 1 1 1 1 0 1 1 0 0 0	4109	X	X

(continued)

	Gray level	Code word	Center of gravity	Code set S_1	Code set S_2	Code set S_3
5	65	1 1 0 1 0 1 1 1 0 0 0	4273	X		
66	66	1 0 1 1 0 1 1 1 0 0 0	4253	X		
67	67	0 1 1 1 0 1 1 1 0 0 0	4215	X		
68	68	1 1 1 1 0 1 1 1 0 0 0	4162	X	X	
10	69	1 0 1 0 1 1 1 1 0 0 0	4244	X		
70	70	0 1 1 0 1 1 1 1 0 0 0	4209	X	X	
71	71	1 1 1 0 1 1 1 1 0 0 0	4157	X		
15	72	0 1 0 1 1 1 1 1 0 0 0	4183	X		
73	73	1 1 0 1 1 1 1 1 0 0 0	4133	X		
74	74	1 0 1 1 1 1 1 1 0 0 0	4117	X		
20	75	0 1 1 1 1 1 1 1 0 0 0	4086	X		
76	76	1 1 1 1 1 1 1 1 0 0 0	4040	X		
77	77	0 1 1 1 1 0 1 0 1 0 0	4835	X		
78	78	1 1 1 1 1 0 1 0 1 0 0	4780	X		
25	79	1 1 0 1 0 1 1 0 1 0 0	4907	X		
80	80	1 0 1 1 0 1 1 0 1 0 0	4882	X		
81	81	0 1 1 1 0 1 1 0 1 0 0	4844	X		
30	82	1 1 1 1 0 1 1 0 1 0 0	4791	X		
83	83	1 0 1 0 1 1 1 0 1 0 0	4852	X		
84	84	0 1 1 0 1 1 1 0 1 0 0	4815	X		
85	85	1 1 1 0 1 1 1 0 1 0 0	4766	X		
35	86	0 1 0 1 1 1 1 0 1 0 0	4780	X		
87	87	1 1 0 1 1 1 1 0 1 0 0	4731	X		
88	88	1 0 1 1 1 1 1 0 1 0 0	4711	X		
40	89	0 1 1 1 1 1 1 0 1 0 0	4678	X		
90	90	1 1 1 1 1 1 1 0 1 0 0	4632	X	X	
91	91	1 1 1 1 0 1 0 1 1 0 0	4988	X		
92	92	1 0 1 0 1 1 0 1 1 0 0	5040	X		
45	93	0 1 1 0 1 1 0 1 1 0 0	5005	X		
94	94	1 1 1 0 1 1 0 1 1 0 0	4958	X		
95	95	0 1 0 1 1 1 0 1 1 0 0	4969	X		
50	96	1 1 0 1 1 1 0 1 1 0 0	4923	X		
97	97	1 0 1 1 1 1 0 1 1 0 0	4903	X		
98	98	0 1 1 1 1 1 0 1 1 0 0	4870	X		
99	99	1 1 1 1 1 1 0 1 1 0 0	4827	X	X	
55	100	1 1 1 0 1 0 1 1 1 0 0	5010	X		
101	101	0 1 0 1 1 0 1 1 1 0 0	5020	X		
	102	1 1 0 1 1 0 1 1 1 0 0	4976	X		

(continued)

	Gray level	Code word	Center of gravity	Code set S_1	Code set S_2	Code set S_3
5	103	1 0 1 1 1 0 1 1 1 0 0	4957	X		
10	104	0 1 1 1 1 0 1 1 1 0 0	4926	X		
15	105	1 1 1 1 1 0 1 1 1 0 0	4884	X	X	X
20	106	1 1 0 1 0 1 1 1 1 0 0	4978	X		
25	107	1 0 1 1 0 1 1 1 1 0 0	4959	X		
30	108	0 1 1 1 0 1 1 1 1 0 0	4929	X		
35	109	1 1 1 1 0 1 1 1 1 0 0	4889	X	X	
40	110	1 0 1 0 1 1 1 1 1 0 0	4934	X		
45	111	0 1 1 0 1 1 1 1 1 0 0	4905	X	X	
50	112	1 1 1 0 1 1 1 1 1 0 0	4867	X		
55	113	0 1 0 1 1 1 1 1 1 0 0	4876	X		
	114	1 1 0 1 1 1 1 1 1 0 0	4839	X		
	115	1 0 1 1 1 1 1 1 1 0 0	4822	X		
	116	0 1 1 1 1 1 1 1 1 0 0	4796	X		
	117	1 1 1 1 1 1 1 1 1 0 0	4760	X		
	118	0 1 0 1 1 0 1 1 0 1 0	5698	X		
	119	1 1 0 1 1 0 1 1 0 1 0	5655	X		
	120	1 0 1 1 1 0 1 1 0 1 0	5633	X		
	121	0 1 1 1 1 0 1 1 0 1 0	5600	X		
	122	1 1 1 1 1 0 1 1 0 1 0	5559	X		
	123	1 1 0 1 0 1 1 1 0 1 0	5634	X		
	124	1 0 1 1 0 1 1 1 0 1 0	5612	X		
	125	0 1 1 1 0 1 1 1 0 1 0	5581	X		
	126	1 1 1 1 0 1 1 1 0 1 0	5542	X		
	127	1 0 1 0 1 1 1 1 0 1 0	5576	X		
	128	0 1 1 0 1 1 1 1 0 1 0	5546	X		
	129	1 1 1 0 1 1 1 1 0 1 0	5507	X		
	130	0 1 0 1 1 1 1 1 0 1 0	5511	X		
	131	1 1 0 1 1 1 1 1 0 1 0	5473	X		
	132	1 0 1 1 1 1 1 1 0 1 0	5454	X		
	133	0 1 1 1 1 1 1 1 0 1 0	5426	X		
	134	1 1 1 1 1 1 1 1 0 1 0	5390	X	X	
	135	0 1 1 1 1 0 1 0 1 1 0	5834	X		
	136	1 1 1 1 1 0 1 0 1 1 0	5795	X		
	137	1 1 0 1 0 1 1 0 1 1 0	5860	X		
	138	1 0 1 1 0 1 1 0 1 1 0	5839	X		
	139	0 1 1 1 0 1 1 0 1 1 0	5810	X		
	140	1 1 1 1 0 1 1 0 1 1 0	5773	X		

(continued)

	Gray level	Code word	Center of gravity	Code set S_1	Code set S_2	Code set S_3
5	141	1 0 1 0 1 1 1 0 1 1 0	5801	X		
10	142	0 1 1 0 1 1 1 0 1 1 0	5773	X		
14	143	1 1 1 0 1 1 1 0 1 1 0	5737	X		
14	144	0 1 0 1 1 1 1 0 1 1 0	5738	X		
10	145	1 1 0 1 1 1 1 0 1 1 0	5703	X		
14	146	1 0 1 1 1 1 1 0 1 1 0	5684	X		
15	147	0 1 1 1 1 1 1 0 1 1 0	5657	X		
14	148	1 1 1 1 1 1 1 0 1 1 0	5623	X	X	
14	149	1 1 1 1 0 1 0 1 1 1 0	5833	X		
20	150	1 0 1 0 1 1 0 1 1 1 0	5860	X		
14	151	0 1 1 0 1 1 0 1 1 1 0	5833	X		
20	152	0 1 0 1 1 1 0 1 1 1 0	5798	X		
14	153	0 1 0 1 1 1 0 1 1 1 0	5799	X		
25	154	1 1 0 1 1 1 0 1 1 1 0	5765	X		
14	155	1 0 1 1 1 1 0 1 1 1 0	5747	X		
14	156	0 1 1 1 1 1 0 1 1 1 0	5721	X		
14	157	1 1 1 1 1 1 0 1 1 1 0	5689	X	X	
30	158	1 1 1 0 1 0 1 1 1 1 0	5799	X		
14	159	0 1 0 1 1 0 1 1 1 1 0	5800	X		
14	160	1 1 0 1 1 0 1 1 1 1 0	5768	X		
14	161	1 0 1 1 1 0 1 1 1 1 0	5750	X		
35	162	0 1 1 1 1 0 1 1 1 1 0	5725	X		
14	163	1 1 1 1 1 0 1 1 1 1 0	5694	X	X	X
14	164	1 1 0 1 0 1 1 1 1 1 0	5749	X		
40	165	1 0 1 1 0 1 1 1 1 1 0	5732	X		
14	166	0 1 1 1 0 1 1 1 1 1 0	5708	X	X	
14	167	1 1 1 1 0 1 1 1 1 1 0	5677	X		
14	168	1 0 1 0 1 1 1 1 1 1 0	5702	X		
45	169	0 1 1 0 1 1 1 1 1 1 0	5679	X		
14	170	0 1 0 1 1 1 1 1 1 1 0	5649	X		
14	171	0 1 1 0 1 1 1 1 1 1 0	5651	X		
50	172	1 1 0 1 1 1 1 1 1 1 0	5621	X		
14	173	1 0 1 1 1 1 1 1 1 1 0	5606	X		
14	174	0 1 1 1 1 1 1 1 1 1 0	5584	X		
14	175	1 1 1 1 1 1 1 1 1 1 0	5555	X		
55	176	1 1 0 1 1 1 0 1 1 0 1	6512	X		
14	177	1 0 1 1 1 1 0 1 1 0 1	6492	X		
14	178	0 1 1 1 1 1 0 1 1 0 1	6465	X		

(continued)

	Gray level	Code word	Center of gravity	Code set S_1	Code set S_2	Code set S_3
5	179	1 1 1 1 1 0 1 1 0 1	6433	X		
10	180	1 1 1 0 1 0 1 1 1 0 1	6525	X		
15	181	0 1 0 1 1 0 1 1 1 0 1	6522	X		
20	182	1 1 0 1 1 0 1 1 1 0 1	6490	X		
25	183	1 0 1 1 1 0 1 1 1 0 1	6470	X		
30	184	0 1 1 1 1 0 1 1 1 0 1	6445	X		
35	185	1 1 1 1 1 0 1 1 1 0 1	6413	X		
40	186	1 1 0 1 0 1 1 1 1 0 1	6458	X		
45	187	1 0 1 1 0 1 1 1 1 0 1	6439	X		
50	188	0 1 1 1 0 1 1 1 1 0 1	6414	X		
55	189	1 1 1 1 0 1 1 1 1 0 1	6383	X		
	190	1 0 1 0 1 1 1 1 1 0 1	6402	X		
	191	0 1 1 0 1 1 1 1 1 0 1	6377	X		
	192	1 1 1 0 1 1 1 1 1 0 1	6347	X		
	193	0 1 0 1 1 1 1 1 1 0 1	6345	X		
	194	1 1 0 1 1 1 1 1 1 0 1	6315	X		
	195	1 0 1 1 1 1 1 1 1 0 1	6298	X		
	196	0 1 1 1 1 1 1 1 1 0 1	6275	X		
	197	1 1 1 1 1 1 1 1 1 0 1	6246	X	X	
	198	0 1 0 1 1 0 1 1 0 1	6798	X		
	199	1 1 0 1 1 0 1 1 0 1 1	6766	X		
	200	1 0 1 1 1 0 1 1 0 1 1	6747	X		
	201	0 1 1 1 1 0 1 1 0 1 1	6722	X		
	202	1 1 1 1 1 0 1 1 0 1 1	6692	X		
	203	1 1 0 1 0 1 1 1 0 1 1	6732	X		
	204	1 0 1 1 0 1 1 1 0 1 1	6713	X		
	205	0 1 1 1 0 1 1 1 0 1 1	6689	X		
	206	1 1 1 1 0 1 1 1 0 1 1	6659	X		
	207	1 0 1 0 1 1 1 1 0 1 1	6675	X		
	208	0 1 1 0 1 1 1 1 0 1 1	6651	X		
	209	1 1 1 0 1 1 1 1 0 1 1	6622	X		
	210	0 1 0 1 1 1 1 1 0 1 1	6619	X		
	211	1 1 0 1 1 1 1 1 0 1 1	6590	X		
	212	1 0 1 1 1 1 1 1 0 1 1	6573	X		
	213	0 1 1 1 1 1 1 1 0 1 1	6550	X		
	214	1 1 1 1 1 1 1 1 0 1 1	6522	X	X	
	215	0 1 1 1 1 0 1 0 1 1 1	6796	X		
	216	1 1 1 1 1 0 1 0 1 1 1	6767	X		

(continued)

	Gray level	Code word	Center of gravity	Code set S_1	Code set S_2	Code set S_3
5	217	1 1 0 1 0 1 1 0 1 1 1	6804	X		
	218	1 0 1 1 0 1 1 0 1 1 1	6786	X		
	219	0 1 1 1 0 1 1 0 1 1 1	6763	X		
10	220	1 1 1 1 0 1 1 0 1 1 1	6735	X		
	221	1 0 1 0 1 1 1 0 1 1 1	6749	X		
	222	0 1 1 0 1 1 1 0 1 1 1	6727	X		
	223	1 1 1 0 1 1 1 0 1 1 1	6699	X		
15	224	0 1 0 1 1 1 1 0 1 1 1	6696	X		
	225	1 1 0 1 1 1 1 0 1 1 1	6669	X		
	226	1 0 1 1 1 1 1 0 1 1 1	6652	X		
20	227	0 1 1 1 1 1 1 0 1 1 1	6631	X		
	228	1 1 1 1 1 1 1 0 1 1 1	6604	X	X	
	229	1 1 1 1 0 1 0 1 1 1 1	6737	X		
	230	1 0 1 0 1 1 0 1 1 1 1	6750	X		
25	231	0 1 1 0 1 1 0 1 1 1 1	6728	X		
	232	1 1 1 0 1 1 0 1 1 1 1	6702	X		
	233	0 1 0 1 1 1 0 1 1 1 1	6699	X		
30	234	1 1 0 1 1 1 0 1 1 1 1	6673	X		
	235	1 0 1 1 1 1 0 1 1 1 1	6657	X		
	236	0 1 1 1 1 1 0 1 1 1 1	6636	X		
	237	1 1 1 1 1 1 0 1 1 1 1	6610	X	X	
35	238	1 1 1 0 1 0 1 1 1 1 1	6680	X		
	239	0 1 0 1 1 0 1 1 1 1 1	6677	X		
	240	1 1 0 1 1 0 1 1 1 1 1	6652	X		
40	241	1 0 1 1 1 0 1 1 1 1 1	6636	X		
	242	0 1 1 1 1 0 1 1 1 1 1	6616	X	X	X
	243	1 1 1 1 1 0 1 1 1 1 1	6591	X		
45	244	1 1 0 1 0 1 1 1 1 1 1	6625	X	X	
	245	1 0 1 1 0 1 1 1 1 1 1	6610	X		
	246	0 1 1 1 0 1 1 1 1 1 1	6590	X		
	247	1 1 1 1 0 1 1 1 1 1 1	6566	X		
50	248	1 0 1 0 1 1 1 1 1 1 1	6579	X		
	249	0 1 1 0 1 1 1 1 1 1 1	6559	X		
	250	1 1 1 0 1 1 1 1 1 1 1	6535	X		
	251	0 1 0 1 1 1 1 1 1 1 1	6533	X		
55	252	1 1 0 1 1 1 1 1 1 1 1	6510	X		
	253	1 0 1 1 1 1 1 1 1 1 1	6496	X		
	254	0 1 1 1 1 1 1 1 1 1 1	6477	X		

(continued)

5

Gray level	Code word	Center of gravity	Code set S ₁	Code set S ₂	Code set S ₃
255	1 1 1 1 1 1 1 1 1 1	6454	X	X	X

Claims

1. Method for coding video levels of pixels of a colour component of a picture to be displayed on a display device into a code word belonging to at least a first code set (S₁) and/or a second code set (S₂), the second code set (S₂) being a subset of the first code set (S₁), **characterized in that** it comprises the following steps:

- determining (103, 107), for each pixel of the picture, at least a first floor level (F₁) and a first ceiling level (C₁) that can be coded by a code word of the first code set (S₁) and a second floor level (F₂) and a second ceiling level (C₂) that can be coded by a code word of the second code set (S₂), the first and second floor levels (F₁, F₂) being respectively the highest video level among the video levels corresponding to the code words of the first and second code sets (S₁, S₂) equal to or lower than the video level (I) of the considered pixel and the first and second ceiling levels (C₁, C₂) being respectively the lowest video level among the video levels corresponding to the code words of the first and second code sets (S₁, S₂) equal to or higher than the video level (I) of the considered pixel,
- determining (105, 106), for each current pixel (X_p), a floor level and ceiling level (F(X_p), C(X_p)) on the basis of the first floor level and first ceiling level (F₁(X_p), C₁(X_p)) of said current pixel and the first floor levels and first ceiling levels (f₁[X_{p-L1/2}, X_{p+L1/2}], C₁[X_{p-L1/2}, X_{p+L1/2}]) of a predetermined number (L1) neighbouring pixels belonging to a window including the current pixel (X_p),
- substituting (108, 111), for each current pixel (X_p), the floor level (F(X_p) by the second floor level (F₂(X_p)) if the said floor level (F(X_p)) is lower than the second floor level and the ceiling level (C(X_p)) by the second ceiling level (C₂(X_p)) if said ceiling level is lower than the second ceiling level, and
- selecting (230), for each current pixel; the code word among the code word of the floor level (F(X_p) and the code word of the new ceiling level (F(X_p) for coding the video level of the current pixel.

2. Method according to Claim 1, wherein it further comprises a step (250) for encoding, for each current pixel, the selected code word into a subfield code word, wherein to each bit of the subfield code word a certain duration is assigned, hereinafter called sub-field, during which a pixel can be activated for light generation.

3. Method according to Claim 2, wherein the code words of the second code set are selected among the code words of the first code set according to the rule that the temporal centre of gravity (CG1, CG2, CG3) for the light generation of the corresponding sub-field code words grows continuously with the video level of said code words apart from exceptions in the low video level range up to a first predetermined limit and/or for in the high video level range from a second predetermined limit on.

4. Method according to any one of claims 1 to 3, wherein the step (105, 106) for determining the floor level of the current pixel comprises the step of allocating (105) the first floor level of the current pixel to the floor level and the step of substituting (106) said floor level of the current pixel by the highest first ceiling level in the window (f₁[X_{p-L1/2}, X_{p+L1/2}]) and the step (105, 106) for determining the ceiling level of the current pixel comprises the step of allocating (105) the first ceiling level of the current pixel to the ceiling level and the step of substituting (106) said ceiling level of the current pixel by the lowest first floor level in the window (c₁[X_{p-L1/2}, X_{p+L1/2}]).

5. Method according to any one of claims 1 to 4, wherein the step of selecting the code word of the current pixel among the code word of the floor level (F(x)) and the code word of the ceiling level (C(x)) comprises the following steps :

- computing a coefficient α such that $I(x) = \alpha \cdot c(x) + (1-\alpha) \cdot f(x)$ where
 - I(x) is the video level of the current pixel x,
 - c(x) is the new ceiling level of the current pixel, and
 - f(x) is the new floor level of the current pixel,
- generating a random number N_{rnd} such that $0 \leq N_{rnd} \leq 1$,

- selecting the ceiling level ($C(x)$) if the coefficient α is greater than or equal to N_{rnd} and selecting the floor level ($F(x)$) if the coefficient α is lower than the random number N_{rnd} .

5 6. Device for coding video levels of pixels of a colour component of a picture to be displayed on a display device into a code word belonging to at least a first code set (S_1) and/or a second code set (S_2), the second code set (S_2) being a subset of the first code set (S_1), **characterized in that** it comprises :

10 - means for determining (220;300), for each pixel of the picture, at least a first floor level (F_1) and a first ceiling level (C_1) that can be coded by a code word of the first code set (S_1) and a second floor level (F_2) and a second ceiling level (C_2) that can be coded by a code word of the second code set (S_2), the first and second floor levels (F_1, F_2) being respectively the highest video level among the video levels corresponding to the code words of the first and second code sets (S_1, S_2) equal to or lower than the video level (l) of the considered pixel and the first and second ceiling levels (C_1, C_2) being respectively the lowest video level among the video levels corresponding to the code words of the first and second code sets (S_1, S_2) equal to or higher than the video level (l) of the considered pixel,

15 - means for determining (220;300), for each current pixel (X_p), a floor level and ceiling level ($F(X_p), C(X_p)$) on the basis of the first floor level and first ceiling level ($F_1(X_p), C_1(X_p)$) of said current pixel and the first floor levels and first ceiling levels ($f_1[X_{p-L/2}, X_{p+L/2}], c_1[X_{p-L/2}, X_{p+L/2}]$) of a predetermined number ($L1$) neighbouring pixels belonging to a window including the current pixel (x_p),

20 - means for substituting (220; 301), for each current pixel (X_p), the floor level ($F(X_p)$) by the second floor level ($F_2(X_p)$) if the said floor level ($F(X_p)$) is lower than the second floor level and the ceiling level ($C(X_p)$) by the second ceiling level ($C_2(X_p)$) if said ceiling level is lower than the second ceiling level, and

25 - dithering means (230) for selecting, for each current pixel, the code word among the code word of the floor level ($F(X_p)$) and the code word of the new ceiling level ($F(x_p)$) for coding the video level of the current pixel.

25 7. Device according to Claim 6, wherein it further comprises subfield encoding means (250) for encoding, for each current pixel, the selected code word into a subfield code word, wherein to each bit of the subfield code word a certain duration is assigned, hereinafter called sub-field, during which a pixel can be activated for light generation .

30 8. Method according to Claim 7, wherein the code words of the second code set are selected among the code words of the first code set according to the rule that the temporal centre of gravity (CG1, CG2, CG3) for the light generation of the corresponding sub-field code words grows continuously with the video level of said code words apart from exceptions in the low video level range up to a first predetermined limit and/or in the high video level range from a second predetermined limit on.

35 9. Device according to any one of claims 6 to 8, wherein the means for determining the floor level of the current pixel comprises means (300) for allocating the first floor level of the current pixel to the floor level and substituting said floor level of the current pixel by the highest first ceiling level in the window ($f_1[X_{p-L/2}, X_{p+L/2}]$) and the means for determining the ceiling level of the current pixel comprises means (300) for allocating the first ceiling level of the current pixel to the ceiling level and substituting said ceiling level of the current pixel by the lowest first floor level in the window ($C_1[X_{p-L/2}, X_{p+L/2}]$).

45

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55

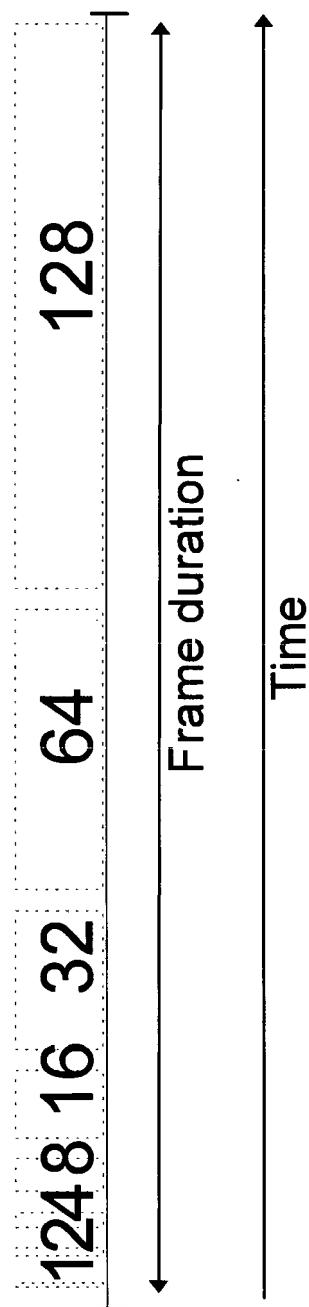


Fig. 1

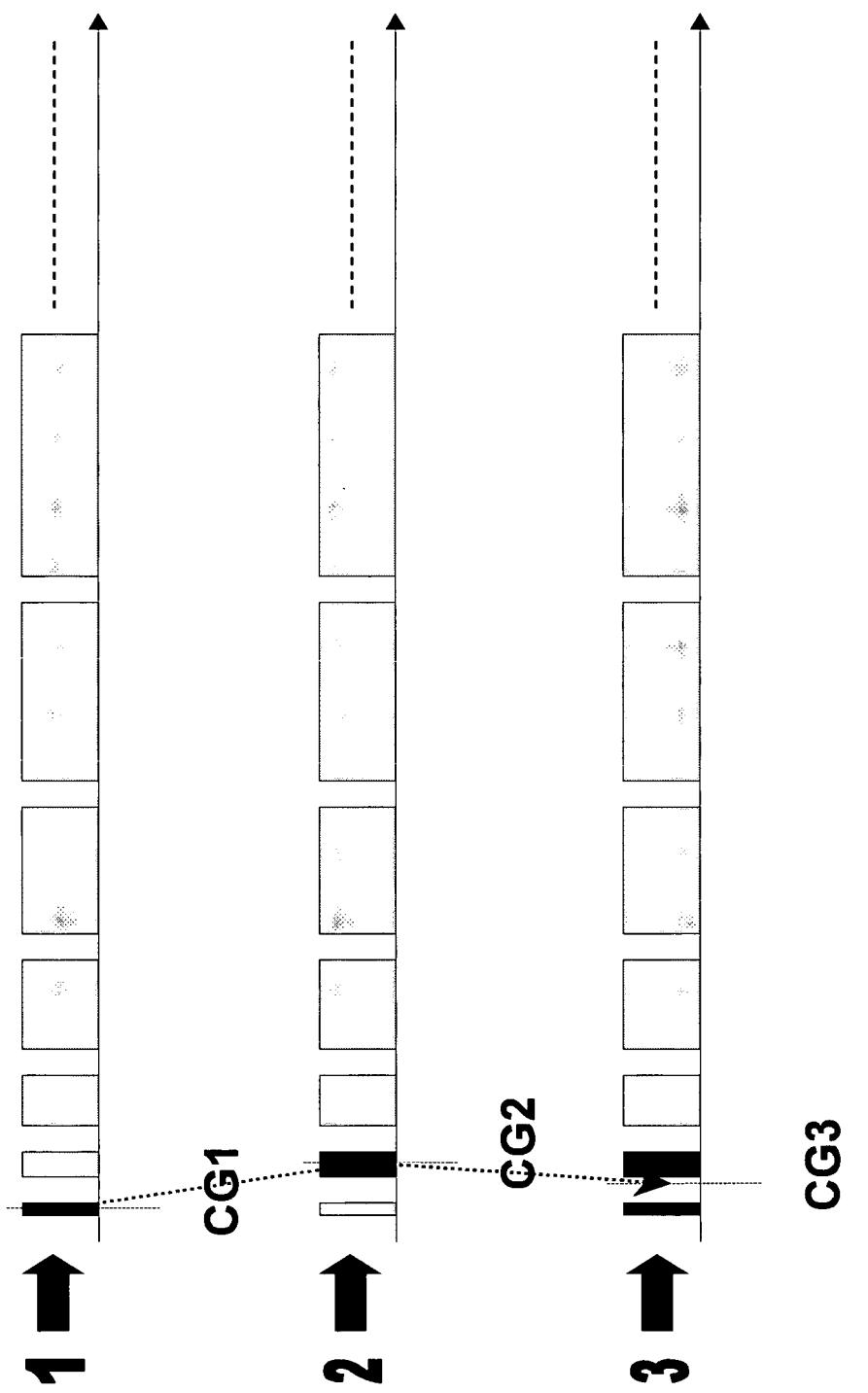


Fig. 2

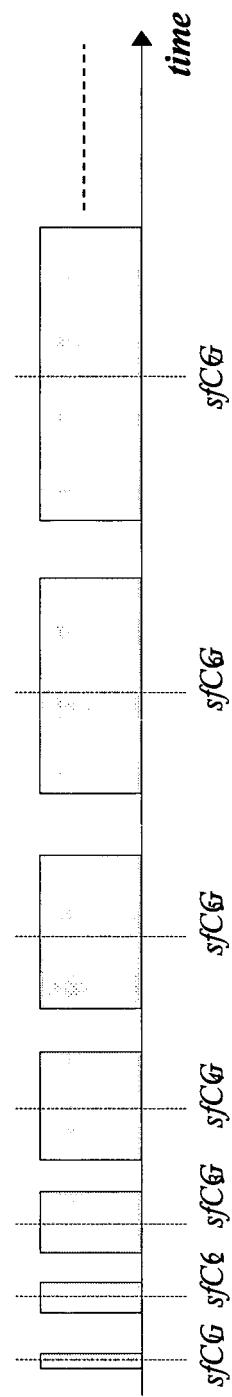


Fig. 3

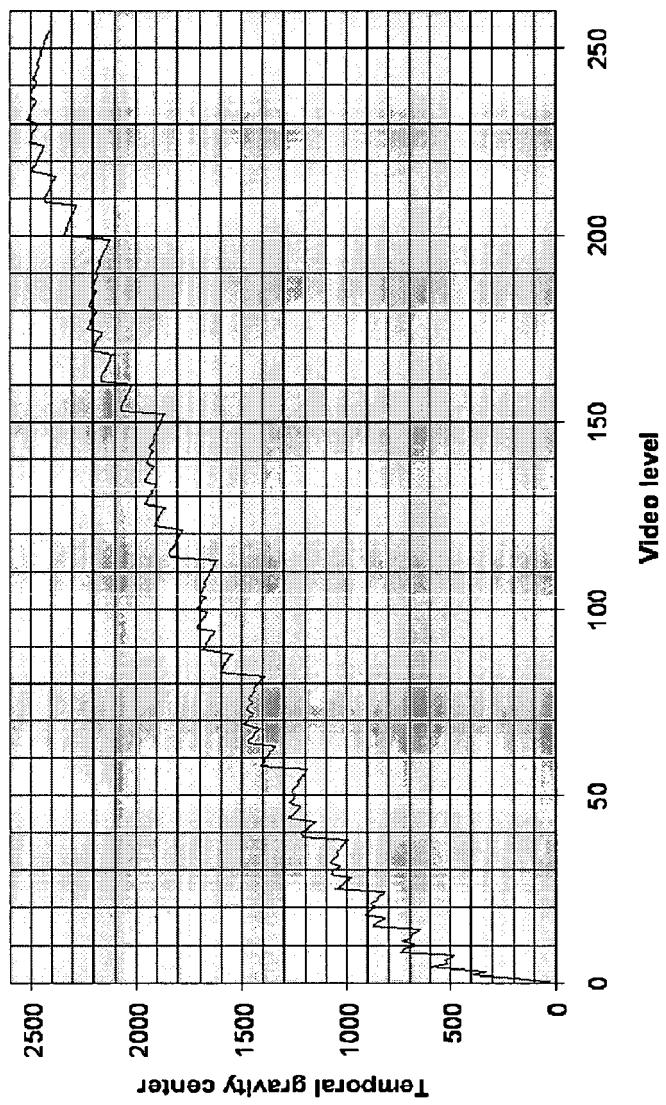


Fig. 4

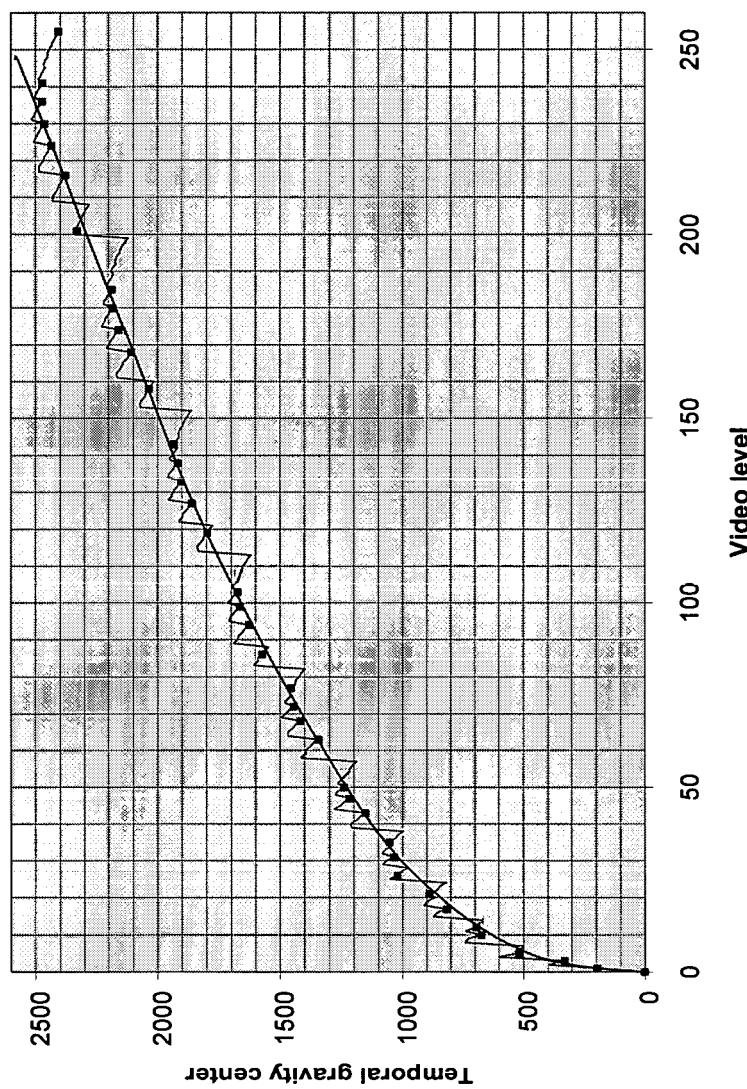


Fig. 5

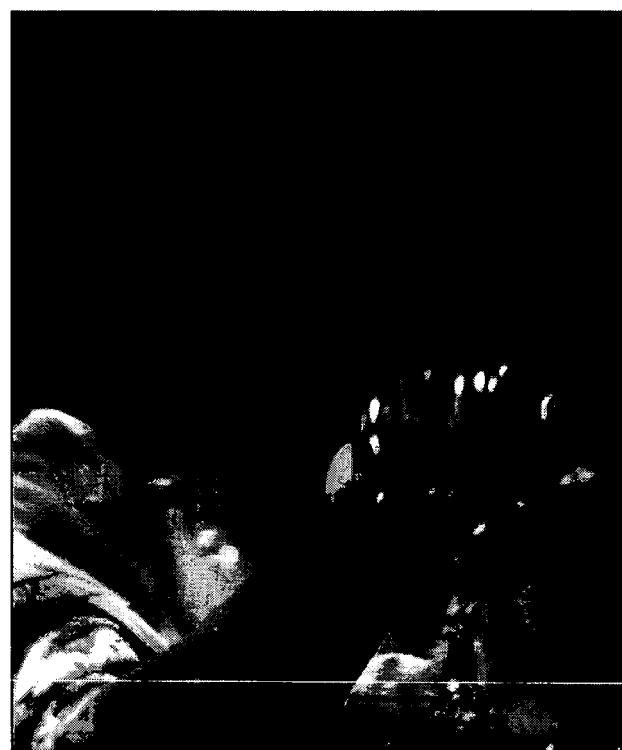


FIG.6

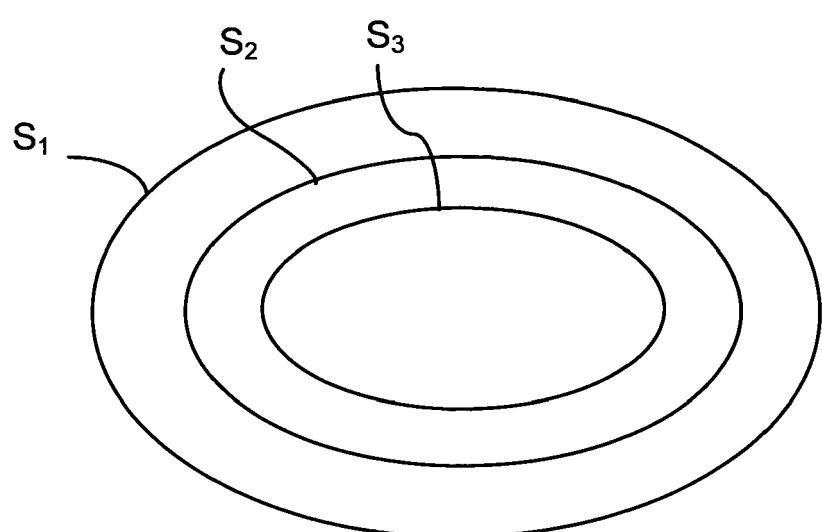


FIG.9

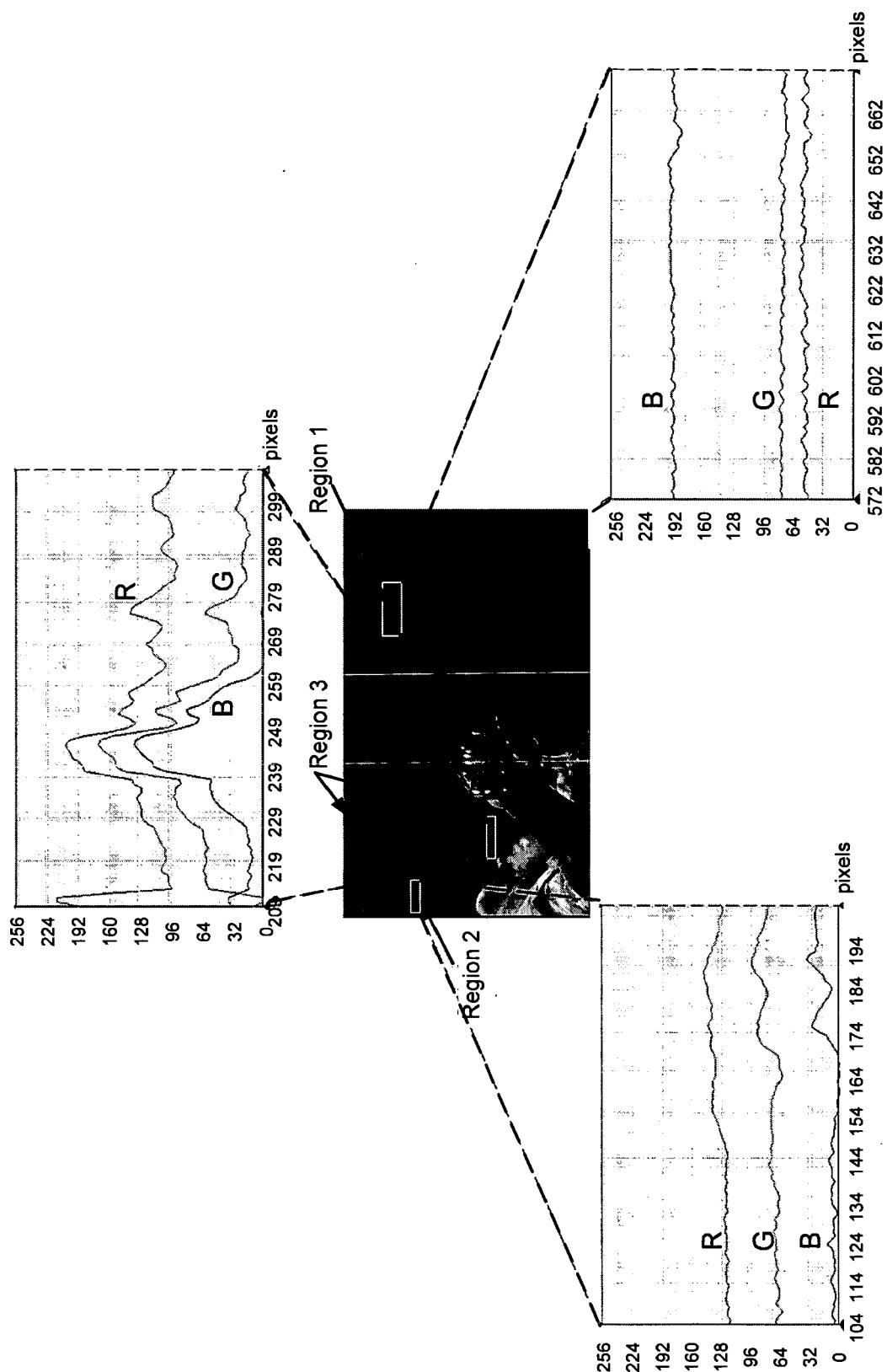


FIG.7

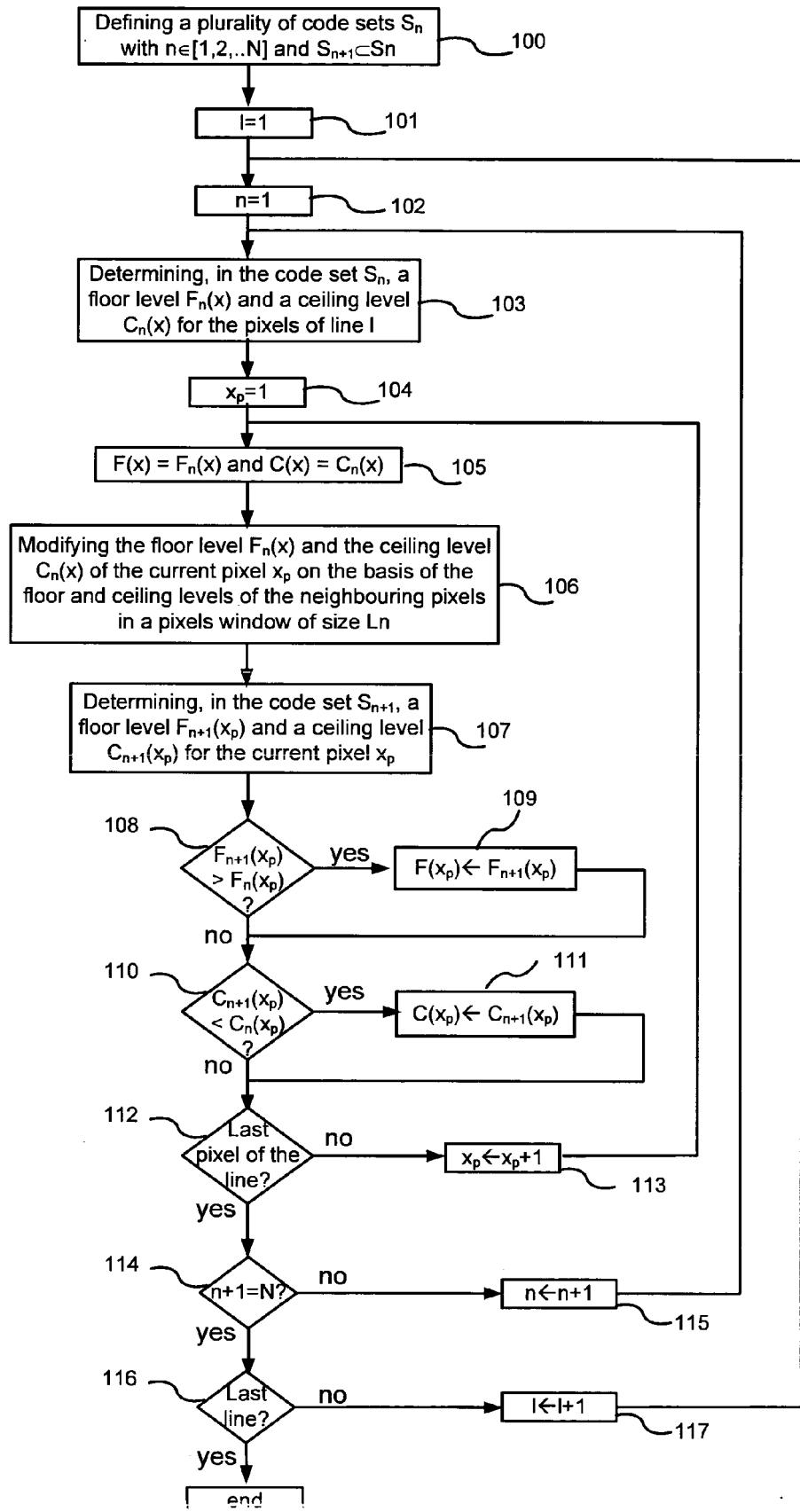


FIG.8

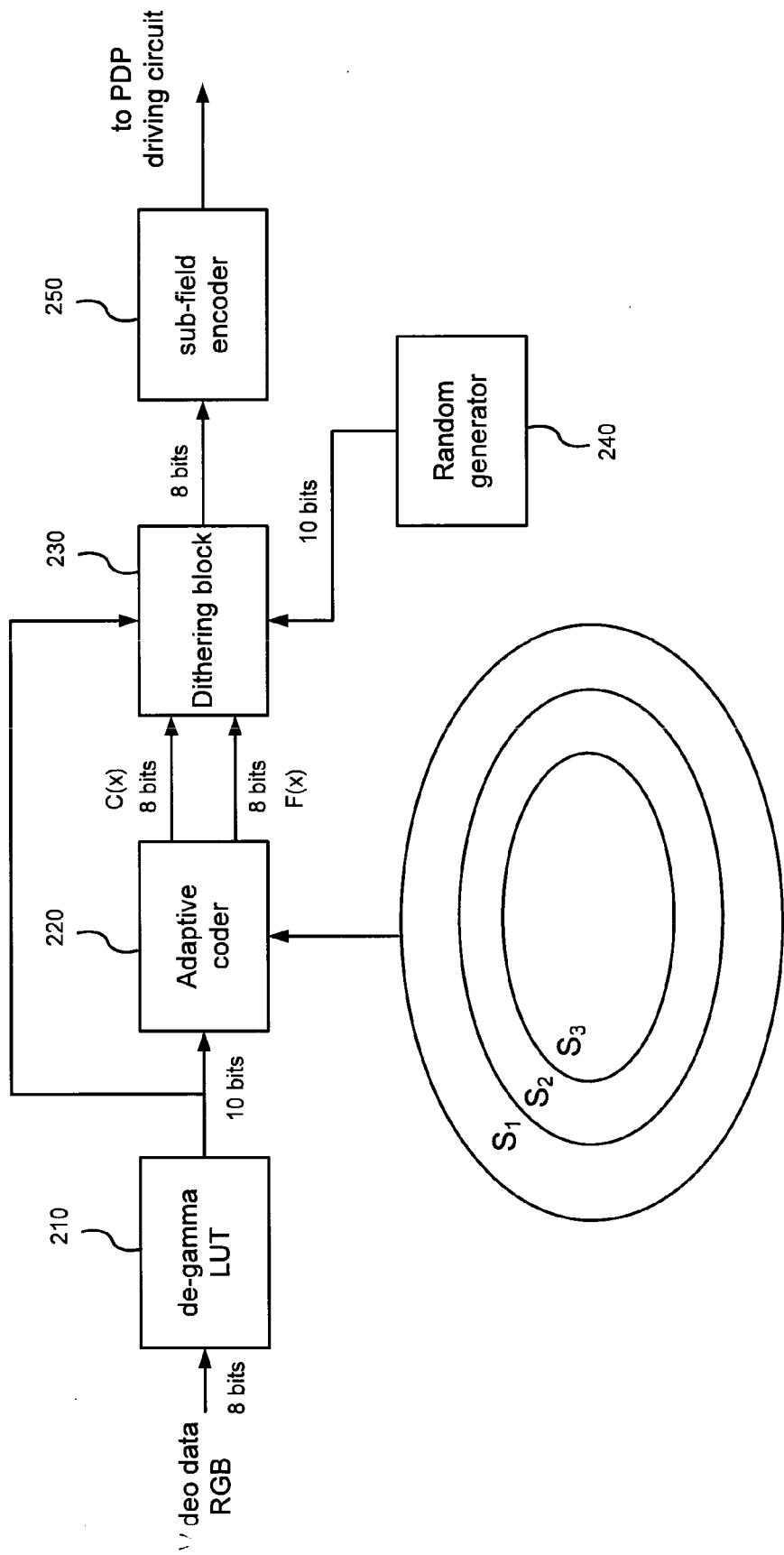


FIG.10

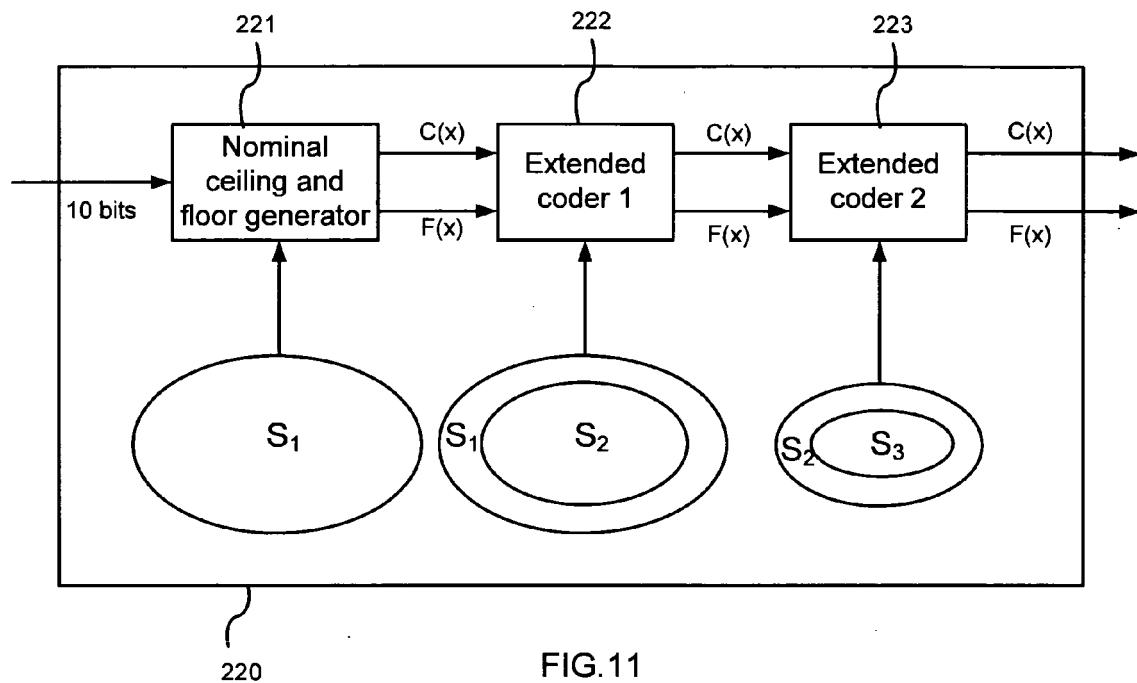


FIG. 11

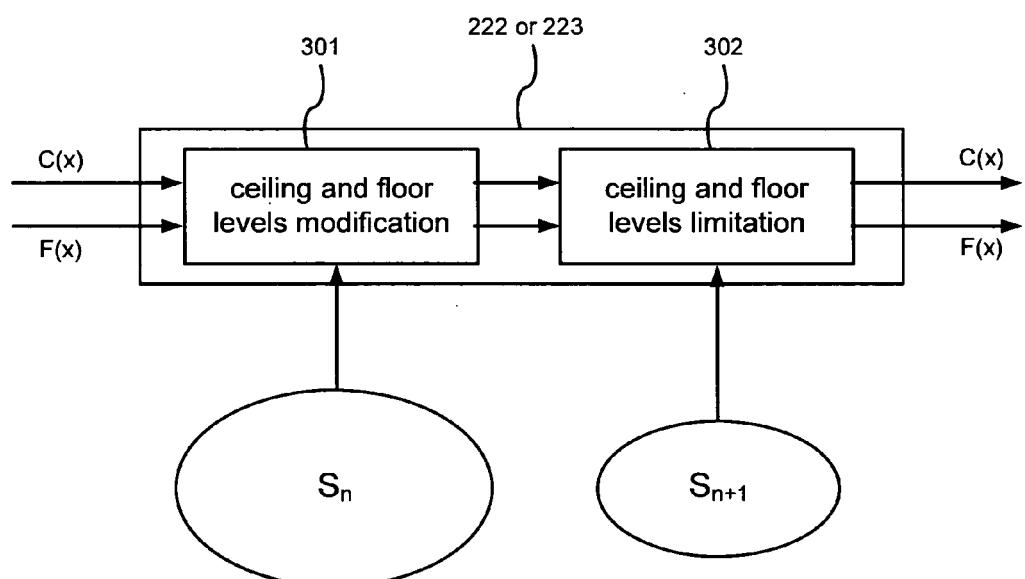


FIG. 12

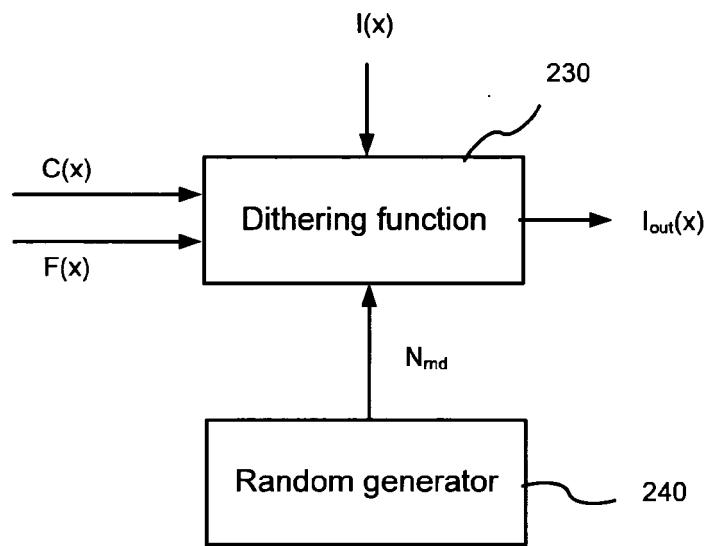


FIG.13

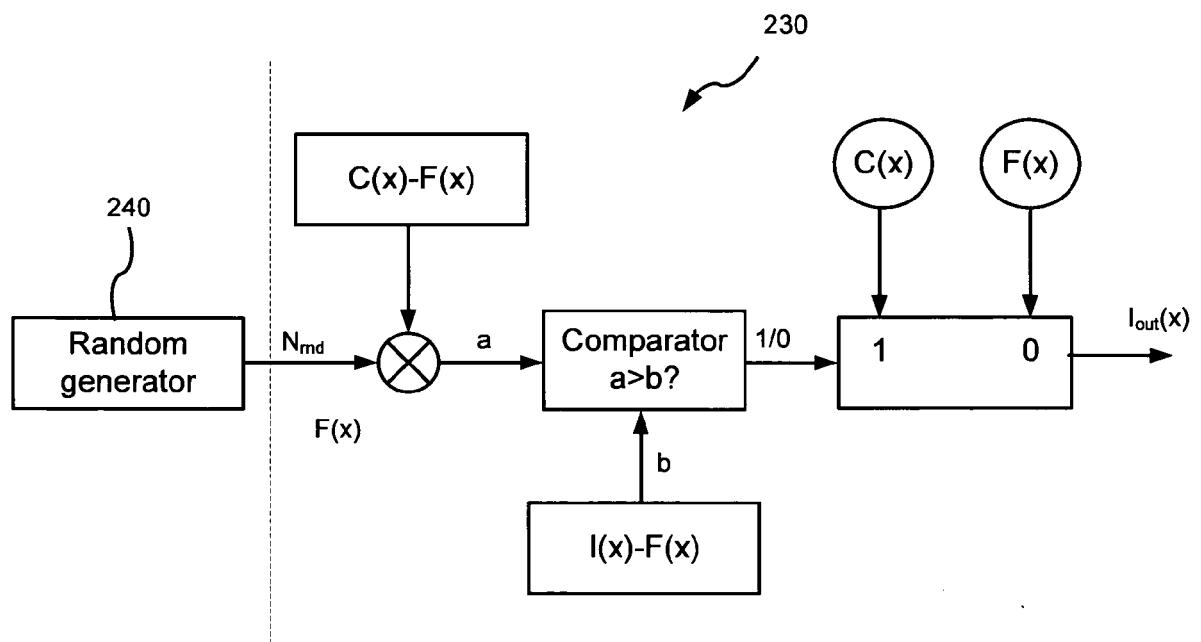


FIG.14



DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (IPC)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
D, X	EP 1 522 964 A (THOMSON LICENSING SA [FR]) 13 April 2005 (2005-04-13)	1-4, 6-9	INV. G09G3/28
Y	* abstract; figures 1-15 * * paragraphs [0014], [0015], [0022], [0023], [0037] - [0039] *	5	
Y	ULICHNEY R A: "DITHERING WITH BLUE NOISE" PROCEEDINGS OF THE IEEE, IEEE, NEW YORK, US, vol. 76, no. 1, January 1988 (1988-01), pages 56-79, XP002034911 ISSN: 0018-9219 Section III, "White Noise Dithering" -----	5	
			TECHNICAL FIELDS SEARCHED (IPC)
			G09G
2	The present search report has been drawn up for all claims		
Place of search		Date of completion of the search	Examiner
The Hague		6 December 2006	Güvener, Cem
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06-12-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1522964	A 13-04-2005	NONE	

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Patent documents cited in the description

- EP 1256924 A [0010]
- EP 1376521 A [0020]
- EP 1522964 A [0021]