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(54) Colour image reproduction

(57) In a color image input/output system, a color original 12 is read out for color separation by a reading device to obtain density signals for respective colors which are converted into dot signals to be fed to an image output device 20,21. Equivalent neutral density signals EN are prepared from the colour separation signals and converted into dot signals at 17 by using dot signal generating tables of the respective colors prepared from the relation between the apparent density and gray wedges previously prepared for the respective colours. The method allows unskilled operators to obtain desired output images easily and quickly without disturbing the whole gradation and gray balance irrespective of the percentage of the black print he chooses.

FIG. 2

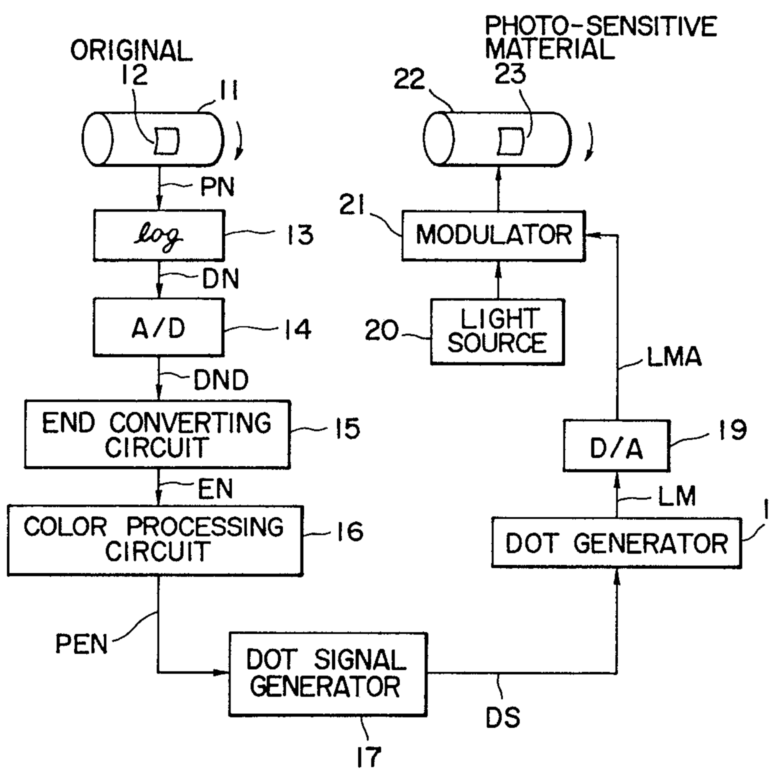

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FIG. 1

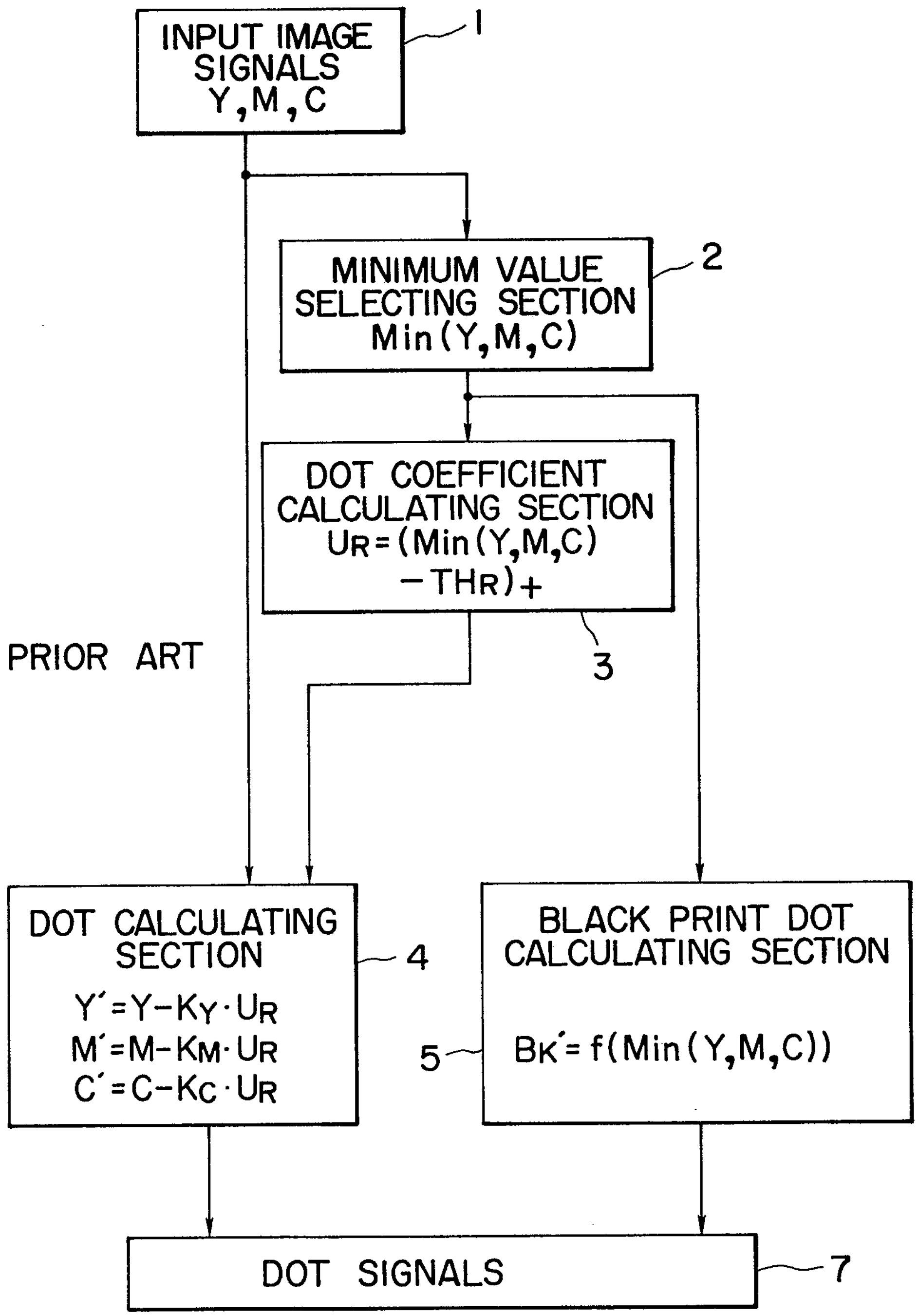
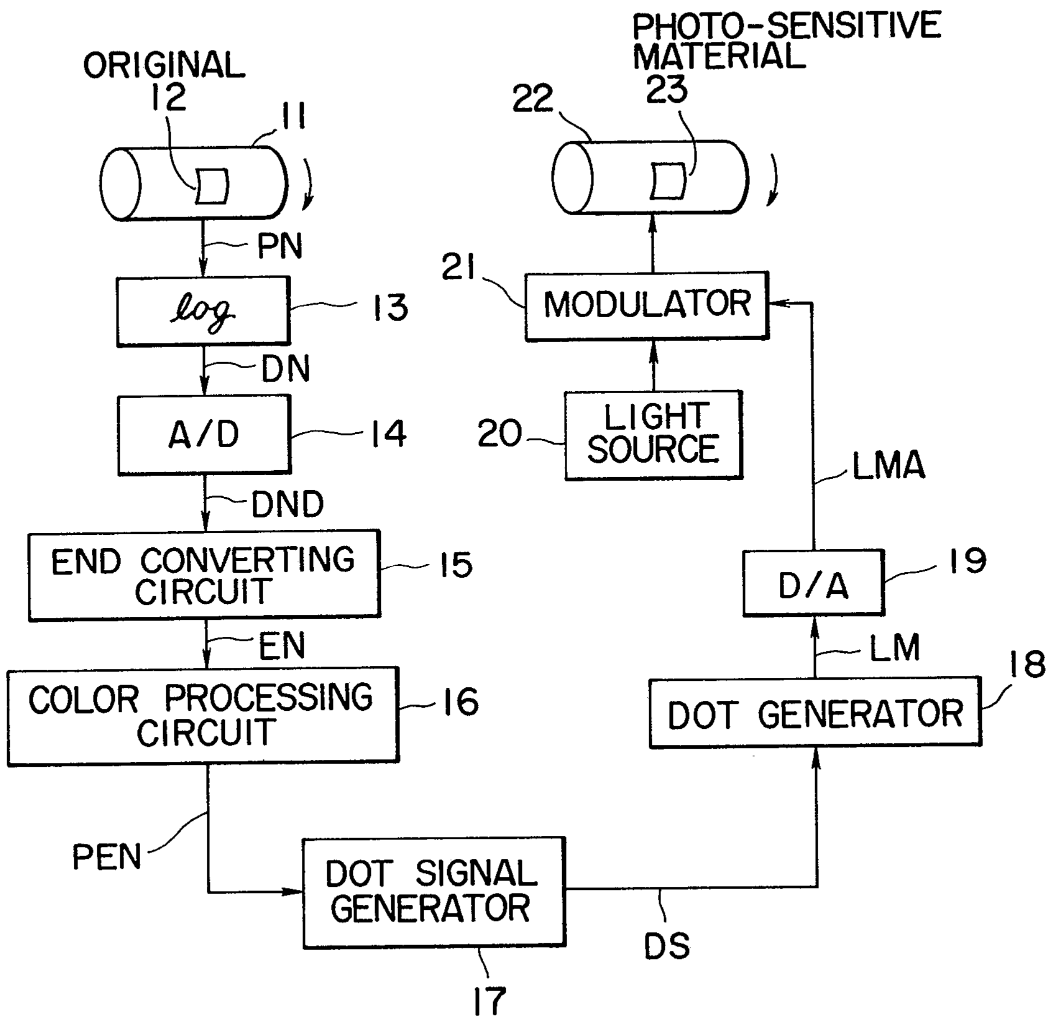

INPUT IMAGE SIGNALS Y, M, C
1
MINIMUM VALUE SELECTING SECTION Min (Y, M, C)
2
DOT COEFFICIENT CALCULATING SECTION UR = (Min (Y, M, C) − THR)+
3
PRIOR ART
DOT CALCULATING SECTION
Y′ = Y − KY · UR
M′ = M − KM · UR
C′ = C − KC · UR
4
BLACK PRINT DOT CALCULATING SECTION
BK′ = f (Min (Y, M, C))
5
DOT SIGNALS
7

FIG. 2


ORIGINAL
12
11
PN
log
13
DN
A/D
14
DND
END CONVERTING CIRCUIT
15
EN
COLOR PROCESSING CIRCUIT
16
PEN
DOT SIGNAL GENERATOR
17
DS
DOT GENERATOR
18
LM
D/A
19
LMA
LIGHT SOURCE
20
MODULATOR
21
22
PHOTO-SENSITIVE MATERIAL
23

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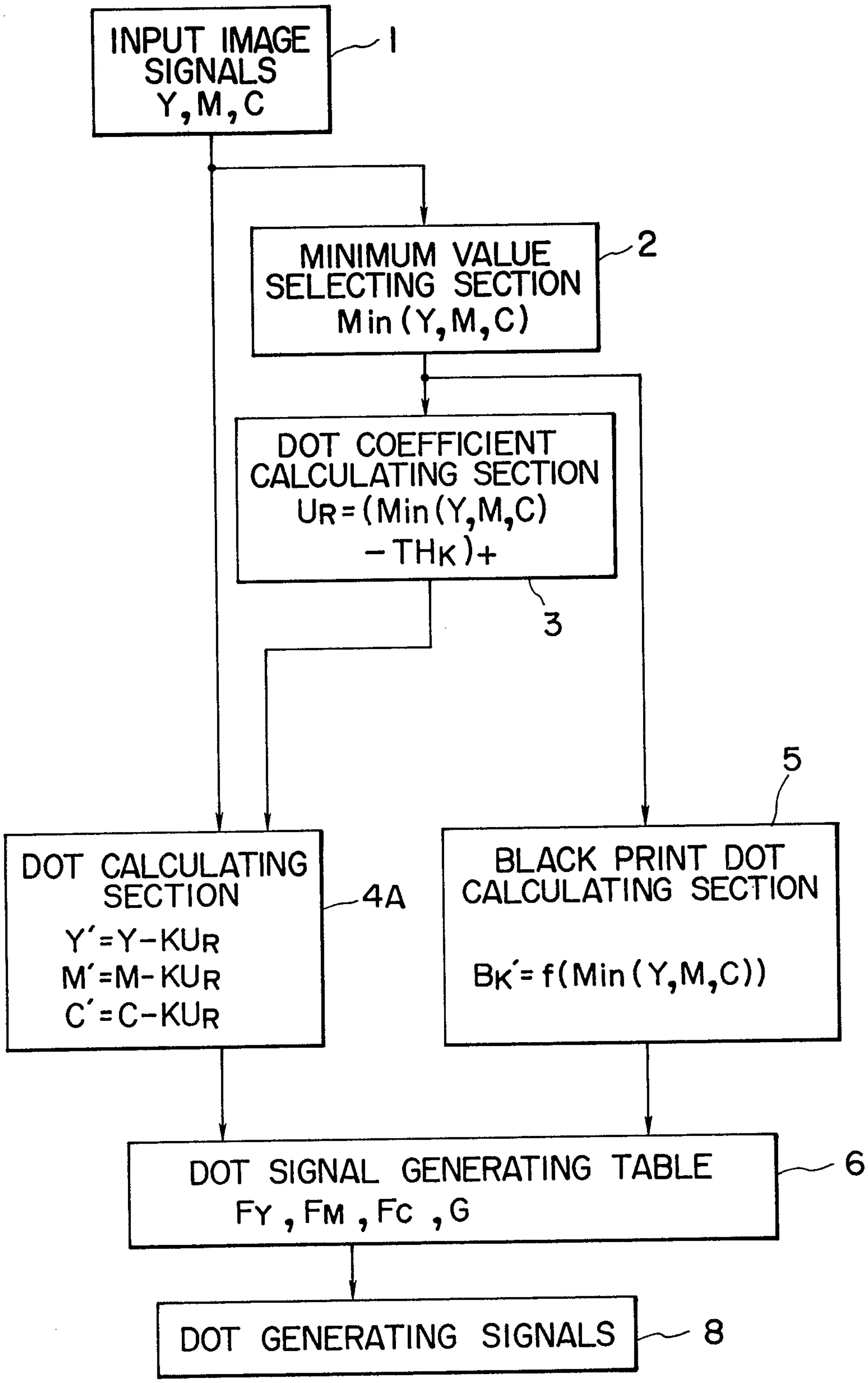

FIG. 3

FIG. 4A

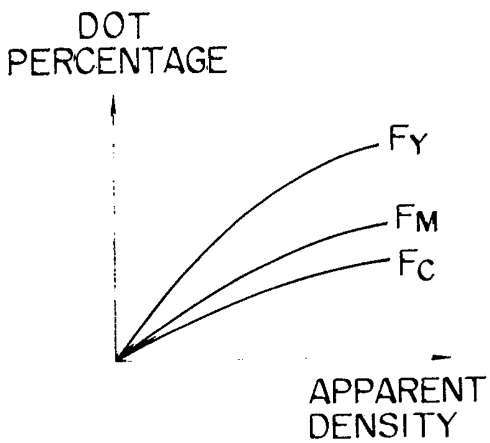

FIG. 4B

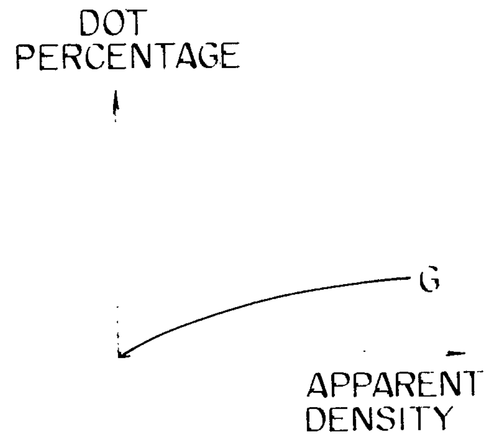

FIG. 5

	Y	M	C	BK
SHADOW	90	90	95	80
MIDDLE	50	50	35	20
HIGH-LIGHT	3	3	5	0

SPECIFICATION

Dot Signal Conversion Method

BACKGROUND OF THE INVENTION

This invention relates to a dot signal conversion method which converts image signals of three primary colors into four color dot signals in a color image input/output system.

In a color image input/output system incorporating a lay-out scanner, a direct scanner, etc., a color manuscript is generally read out for color separation by a reading device, input density signals of the respective colors from the reading device are processed appropriately for colors, and then are converted into dot signals to be fed to an image output device.

Figure 1 is a block diagram to show the processing flow from input image signals 1 (in three colors of Y (yellow), M (magenta) and C (cyan)) to dot signals 7. The minimum values, Min (Y, M, C) of the colors Y, M and C are obtained from the input image signals 1 by a minimum value selecting section 2 to be used in calculation by a dot coefficient calculating section 3 in accordance with the below equation (1).

$$U_R=(\mathrm{Min}\ (Y, M, C)-TH_R)+ \qquad (1)$$

wherein U_R: dot coefficient
Min (Y, M, C): the minimum values of density for Y, M and C.
TH_R: starting point of calculation of dot intensity.
( )+: positive numbers in the result of calculation

The result of calculation is fed to a dot calculating section 4 for respective colors together with the input image signals 1, and they are calculated acccording to the equation (2).

$$\left.\begin{aligned} Y' &= Y - K_Y \cdot U_R \\ M' &= M - K_M \cdot U_R \\ C' &= C - K_C \cdot U_R \end{aligned}\right\} \qquad (2)$$

wherein Y', M', C': dot signals
K_Y, K_M, K_C: dot intensity (full black (ICR) when $0 \leqq K \leqq 1$, $K=1$)

The minimum density signals Min (Y, M, C) of respective colors obtained from the minimum value selecting section 2 are sent to a black print dot calculating section 5 for the calculation with the following equation (3).

$$B_K'=f\ (\mathrm{Min}\ (Y, M, C)) \qquad (3)$$

wherein f: black print gradation table

Dot signals 7 are finally obtained in the four colors of Y', M', C' and B_K (black).

When an operator runs the system having such processing flow, he sets predetermined parameters TH_R, K_Y, K_M, K_C and f, to obtain predetermined dot signals, or in other words, not to disturb the gray balance of the images. However, the number of parameters which should be set by the operator is large in this prior method, and changes and adjustments among these parameters involve complicated works. For instance, if one wishes to increase the percentage of black print (B_K) beyond the ordinary rate, one must change not only the black print gradation table but also K_Y, K_M and K_C, and yet it is extremely difficult to change all of these parameters without disturbing gray balance unless the operator has considerable skill and experience.

SUMMARY OF THE INVENTION

This invention was contrived to obliterate these inconveniences encountered in the prior art and aims of providing a dot signal conversion method which does not disturb the gradation or gray balance as a whole no matter how black a print is selected.

According to one aspect of this invention, for achieving the objects described above, there is provided a dot signal conversion method of the steps of reading a color manuscript for color separation by an image input device, converting thus made density signals of respective colors into equivalent neutral density (END) signals and then into dot signals, and feeding the dot signals into an image output device which is characterized in that gray wedges of respective colors are prepared, dot signal generating tables are prepared from the relation between the apparent density and dot percentage of each gray wedge in record, and said equivalent neutral density (END) signals are color-processed according to a predetermined formula and then converted to said dot signals by using said dot signal generating tables of respective colors.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

Figure 1 is a block diagram to show a prior art image input/output system;

Figure 2 is a block diagram of an enbodiment of the image input/output system which realizes this invention method;

Figure 3 is a block diagram to show an embodiment of the dot signal conversion method of this invention;

Figures 4A and 4B are graphs to show a dot signal generation table; and

Figure 5 is a chart to show an example of dot percentage.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 2 shows an image input/output system which generates dot signals according to an embodiment of this invention method. An original 12 placed on the surface of a rotating input drum 11 is scanned for color separation by an input optical head (not shown) having color separation filters, and image signals PN of respective colors are converted to electric signals by a photoelectric converter to be fed to a logarithmic conversion circuit 13. The image signals PN are converted into density signals DN by the logarithmic conversion circuit 13, then converted into digital signals DN by an A/D converter 14, and inputted to END (Equivalent Neutral Density) converting circuit 15, and digital density signals EN from the circuit 15 are fed to a color processing circuit 16. The color processing circuit 16 executes such processings as the color improvement processing which is disclosed in Japanese Patent Laid Open No. 178355/1983, the sharpness enhancement processing which is disclosed in Japanese Patent Laid Open No. 175055/1983 and other gradation conversion processing. The density signals PEN which have been color processed are outputted from the color processing circuit 16, inputted to a dot signal generator 17, converted into dot signals DS of four colors and inputted to a dot generator 18. They are converted by the dot generator 18 into light amount control signals LM for outputting dot patterns. The light amount control signals LM are converted into analogue amount LMA by a D/A converter 19, and inputted to a modulator 21 which modulates recording light from a light source 20 for exposure. The recording light which has been modulated with the light amount control signals LMA is outputted from an exposure head (not shown) to record the color images on a photo-sensitive material 23 on a rotating output drum 22.

Fig. 3 shows the content of the dot signal generator 17 in a more detailed block diagram. The input image signals 1 are fed to the minimum value selecting section 2 for obtaining the minimum values for Y' (yellow), M (magenta) and C (cyan) respectively, then to the dot coefficient calculating section 3 to carry out the equation (1) mentioned above. The result of calculation is fed to the dot calculating section 4A together with the input image signals 1. The dot claculating section4A calculates in accordance with the equation (2) substituted as below:

$$K_Y = K_M = K_C = K \qquad (4)$$

In other words, the equations (2A) will be conducted.

$$\left.\begin{aligned} Y' &= Y - K \cdot U_R \\ M' &= M - K \cdot U_R \\ C' &= C - K \cdot U_R \end{aligned}\right\} \qquad (2A)$$

The minimum density signals MIN (Y, M, C) for respective colors, obtained from the minimum value selecting section 2 are sent to the black print dot calculating section 5 to conduct the equation (3). The dot signals Y', M', C' and B_K' respectively are inputted into a dot signal generating table 6 to obtain the desired dot percentage. If it is assumed that the dot percentage of respective colors are %Y, %M, %C and %B, and the dot signal generating table 6 are F_Y, F_M, F_C and G, dot generating signals 8 corresponding to the dot signals Y', M', C' and B_K' will be conducted by the following equations.

$$\left.\begin{aligned} \%Y &= F_Y\ (Y') \\ \%M &= F_M\ (M') \\ \%C &= F_C\ (C') \end{aligned}\right\} \qquad (5)$$

Figs. 4A and 4B are the graphs to illustrate a dot signal generating table 6 wherein the relation between apparent density and dot percentage is illustrated. Since these dot signal generating tables F_Y, F_W, F_C and G will be determined automatically if the conditions for image output such as the type of printing ink or printing conditions are given, the gray wedge (A) of only the three stages of Y, M and C in Fig. 4A and the gray wedge (B) of the black print alone are prepared in advance and mounted in a memory, etc. When an operator wishes to increase the ratio of black print for an image larger than usual, he can do so by simply setting the apparent density at a slightly higher level. Since the same apparent density is set at Fig. 4A simultaneously, a desired dot generaion will be easily realized without disturbing the gradation and gray balance of the whole image.

Fig. 5 shows an example of dot percentages of Y, M, C and B_K when apparent densities are roughly classified into shadow, middle and high-light. The table indicates that the relation of the dot percentage will be automatically determined if the conditions such as ink or printing conditions are given as mentioned above. In other words, if one wishes to change the ratio of black print, it can be adjusted easily for each original by an operator by simply increasing/descreasing the black print gradation table *f* by using the black print dot calculating section 5. Any desired image output can be obtained simply by changing F_Y, F_M, F_C and G in Figs. 4A and 4B.

As described in the foregoing, this invention dot signal conversion method conveniently allows unskilled operators to output final images in a desired manner quickly without disturbing the whole gradation tone and gray balance and without the necessity of complicated operation irrespective of the ratio of black print.

It should be understood that many modifications and adaptations of the invention will become apparent to those skilled in the art and it is intended to encompass such obvious modifications and changes in the scope of the claims appended hereto.

CLAIMS

1. A dot signal conversion method of the steps of reading a color original for color separation by an image input device, converting thus made density signals of respective colors into equivalent neutral density signals and then into dot signals, and feeding the dot signals into an image output device which is characterized in that gray wedges of respective colors are prepared, dot signal generating tables are prepared from the relation between the apparent density and dot percentage of each gray wedge in record, and said equivalent neutral density signals are color-processed according to a predetermined formula and then converted to said dot signals by using said dot signals generating tables of respective colors.

2. The dot signal conversion method as claimed in Claim 1 wherein said apparent density is classified into shadow, middle and high-light.

3. The dot signal conversion method as claimed in Claim 1 wherein said input density signals are of the three colors of Y, M and C.

4. The dot signal conversion method as claimed in Claim 3 wherein said input density signals of respective colors are inputted to a minimum value selecting section to select the minimum value, thus selected minimum value is inputted to a dot coefficient calculating section to obtain dot coefficients, and said input density signals and dot coefficients are inputted to a dot calculating section to obtain dots for respective colors.

5. The dot signal conversion method as claimed in Claim 4 wherein said minimum value is inputted to a black print dot calculating section to obtain black print dots.

6. The dot signal conversion method as claimed in Claim 5 wherein said dot signal generating tables of each color are prepared based upon said dots of respective colors and of the black print.

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