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(54) Printing method with camouflage of defective print elements

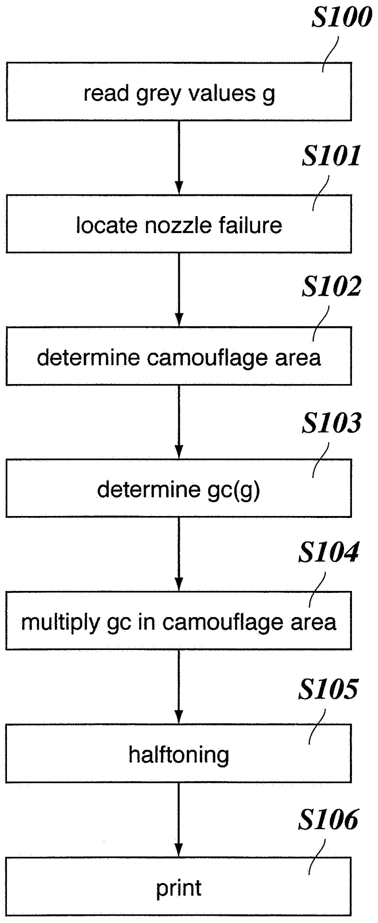
(57) A printing method for a printer having a printhead with a plurality of print elements and capable of printing a binary pixel image, the method comprising the steps of:

a) locating a defective print element,
b) determining a camouflage area in the vicinity of pixels that would have to be printed with the defective print element and
c) camouflaging defective print element by modifying image information in said camouflage area,

characterised in that step c) comprises the steps of:

modifying (S104; S204) a gamma correction function (42) to a modified gamma correction function (46) and
using said modified gamma correction function (46) in said camouflage area.

Fig. 7



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Description

[0001] The invention relates to a printing method for a printer having a printhead with a plurality of print elements and capable of printing a binary pixel image, the method comprising the steps of: locating defective print elements, determining a camouflage area in the vicinity of pixels that would have to be printed with the defective print elements, and camouflaging defective print elements by modifying image information in said camouflage area. The invention further relates to a printer and to a computer program implementing this method.

[0002] The invention is applicable, for example, to an ink jet printer the printhead of which comprises a plurality of nozzles as print elements. Typically, the nozzles are arranged in a line that extends in parallel with the direction (subscanning direction) in which a recording medium, e.g. paper, is transported through the printer, and the printhead scans the paper in a direction (main scanning direction) perpendicular to the subscanning direction. In a single-pass mode is each line printed by only one printing element during a single pass of the printhead. When a nozzle of the printhead is defective, e.g. has become clogged, the corresponding pixel line is missing in the printed image, so that image information is lost and the quality of the print is degraded.

[0003] A printer may also be operated in a multi-pass mode, wherein each line is printed by at least two printing elements. In this case, it is sometimes possible that a defective nozzle is backed-up by a non-defective nozzle, though on the cost of productivity.

[0004] US-A-6 215 557 discloses a method of the type indicated above, wherein, when a nozzle is defective, the print data are altered so as to bypass the faulty nozzle. This means that a pixel that would have but cannot be printed with the defective nozzle is substituted by printing an extra pixel in one of the neighbouring lines that are printed with non-defective nozzles, so that the average optical density of the image area is conserved and the defect resulting from the nozzle failure is camouflaged and becomes almost imperceptible. This method involves a specific algorithm that operates on a bitmap, which represents the print data, and shifts each pixel that cannot be printed to a neighbouring pixel position. However, if this neighbouring pixel position happens to be occupied by a pixel already printed, anyway, pursuant to the original print data, then the extra pixel cannot be printed, and a loss of image information will nevertheless occur.

[0005] It is an object of the invention to provide a printing method in which the camouflage step can be performed more efficiently and is readily integrated in the workflow of the print process.

[0006] According to the invention, the camouflaging step comprises the steps of modifying a gamma correction function to a modified gamma correction function and using said modified gamma correction function in said camouflage area.

[0007] As is well known in the art, the relationship between grey values of pixels to be printed, as encoded in the print data, and the optical density with which the pixel is actually reproduced on the recording medium is described by a so-called gamma curve. This curve is determined by the physical properties of the print process and is in most cases non-linear, so that a linearisation or gamma correction process is required for making sure that slight differences in the grey values in the original image are reproduced equally well over the whole scale of grey levels. Thus, a gamma correction step is typically included in the data processing that is involved in a printing method.

[0008] According to the general idea of the present invention, the fact that a print element of the printer is defective is considered as a physical factor that changes the effective gamma curve of the printer for those areas of the printed image that are affected by the defect, e.g. by a nozzle failure in case of an ink jet printer. Thus, the procedure for camouflaging the effect of the nozzle failure can be implemented very easily by appropriately adapting the gamma correction for the pertinent image area. As a result, the well-known mechanisms that are normally used for correcting the non-linearities of the gamma curve will function to achieve an optical density of the printed image that corresponds to the grey levels of the original image as far as possible, in spite of the nozzle failure. Thus, the invention permits to implement the camouflage step in a very rational way and with only a minimum requirement for data processing time and capacity.

[0009] Useful details and further developments of the invention are indicated in the dependent claims.

[0010] Typically, the gamma correction is performed on the level of the grey value image, i.e. an electronic representation of the image to be printed in the form of a multi-level pixel matrix, where the grey level of each matrix element or pixel is represented by a data word of several bits, e.g. 8 bits, so that the grey levels may range from 0 (white) to 255 (black). Then, one of a plurality of well-known algorithms such as error diffusion or dithering is used for converting the multi-level pixel matrix into a binary pixel image or bitmap such that, although the pixels of the bitmap are either black or white, the distribution of black and white pixels, on the average, still reflects the grey levels of the multi-level pixel matrix. It is also possible as is well known in the art to combine the linearisation and the halftoning algorithm in one computational step. It should be noted that the term "bitmap", as used here, does not mean that a bitmap must actually be stored physically in a storage medium, but only means that the print data are provided in binary form, so that each pixel is represented by a single bit. Thus, the "bitmap" may well be generated "on the fly" during the print process.

[0011] It is one of the advantages of the invention that the camouflage process provides a high degree of flexibility because it is based on the multi-level pixel matrix where the grey levels can be finely adjusted so as to achieve optimal results. Another advantage is that the method can be carried out at a comparatively early stage in the processing sequence, so that the method can also be adapted, for example, to printer hardware which has no sufficient processing capability for carrying out corrections on bitmap level. It is even possible that the method according to the invention is executed in a host computer from which the print data are sent to the printer, provided that the information on the defective nozzles (and the normal gamma curve) of the printer is made available at the host computer. Then, if the printer forms part of a multi-user network, the data processing necessary for carrying out the invention may be distributed over a plurality of computers in the network.

[0012] Depending on the algorithm employed for converting the multi-level data into binary data, such as error diffusion or dithering, the invention will also increase the likelihood that the black pixels that cannot be printed are actually shifted to empty pixel positions in the neighbourhood rather than being lost.

[0013] The invention is particularly useful when the print data that are supplied to the printer are in the multi-level format. However, if these data are in the binary format already, it is a simple matter to reconvert these data into multi-level data, with or without averaging over clusters of adjacent pixels, and then to employ the method as described above.

[0014] When printing in the single-pass mode, the camouflage area where the modified gamma curve applies will be formed by one or more pixel lines adjacent to the line that is affected by the nozzle failure. For example, the camouflage area may then comprise the two direct neighbours of the line that cannot be printed.

[0015] However, the invention is also applicable in multi-pass printing. Then, a nozzle failure will generally not have the effect that a complete line is missing in the printed image, but that, for example in the case of two-pass printing, typically only half the pixels in the line will be missing. In this case, the camouflage area may consist of the remaining, printable pixels in the line in which half of the pixels are missing. Optionally, the camouflage area may also be extended to the adjacent lines.

[0016] In most cases it is a realistic assumption that the grey level of the image is approximately constant on microscopic scale, i.e. over dimensions of not more than a few pixel. Then, the input to the gamma correction process utilising the modified gamma curve may consist only of the lines or pixels that can be printed, and the image information of the non-printable lines or pixels may be ignored. In a modified embodiment, however, it is possible to average the image information over clusters of several pixels including the non-printable pixels and then to use the averaged grey levels as input for the gamma correction.

[0017] Preferred embodiments of the invention will now be explained in conjunction with the drawings, in which:

Fig. 1	is a schematic view of an ink jet printer to which the invention is applicable;
Figs. 2A-C	are diagrams of an area of 6x6 pixels of an image in various representations, illustrating the effect of a nozzle failure and the camouflage process;
Fig. 3	is a diagram of the 6x6-pixel matrix illustrating the construction of a camouflage area for a single-pass print mode;
Fig. 4	is a diagram analogous to figure 3, but illustrating a camouflage area or a two-pass print mode;
Fig. 5	shows examples of gamma curves of a printer;
Fig. 6	shows graphs of a gamma correction functions for linearizing the gamma curves in figure 5;
Fig. 7	is a flow diagram illustrating an embodiment of the method according to the invention;
Fig. 8	is a flow diagram for a modified embodiment of the invention; and
Fig. 9A-C	are diagrams of bitmaps and a pixel matrix illustrating the modified embodiment.

[0018] As is shown in figure 1, an ink jet printer comprises a platen 10 which serves for transporting a recording paper 12 in a subscanning direction (arrow A) past a printhead unit 14. The printhead unit 14 is mounted on a carriage 16 that is guided on guide rails 18 and is movable back and forth in a main scanning direction (arrow B) relative to the recording paper 12. In the example shown, the printhead unit 14 comprises four printheads 20, one for each of the basic colours cyan, magenta, yellow and black. Each printhead has a linear array of nozzles 22 extending in the subscanning direction. The nozzles 22 of the printheads 20 can be energised individually to eject ink droplets onto the recording paper 12, thereby to print a pixel on the paper. When the carriage 16 is moved in the direction B across the width of the paper 12, a swath of an image can be printed. The number of pixel lines of the swath corresponds to the number of nozzles 22 of each printhead. When the carriage 16 has completed a single-pass, the paper 12 is advanced, so that the next single-pass can be printed.

[0019] The printheads 20 are controlled by a processing unit 24 which processes the print data in a manner that will be described in detail hereinbelow. The discussion will be focused on printing in black colour, but is equivalently valid for printing in the other colours.

[0020] Figure 2A shows an array of 6x6 pixels 26, which represents a portion of an image to be printed. The pixels 26 are arranged in lines i-3, i-2, i-1, i, i+1, i+2 and columns j-3, j-2, j-1, j. j+1 and j+2. Black pixels are indicated by dots 28 as printed with the ink jet printer shown in figure 1. Since the ink droplet forming a dot 28 tends to spread on the recording medium (paper), the optical density of the dot decreases gradually from the center toward the periphery, and the lighter peripheral portions of the dot extend beyond the area of the pixel, so that neighbouring dots overlap. The image that has been shown in largely magnified scale in figure 2A would give the impression of a uniform grey area.

[0021] Figure 2B shows the same image in the case that the nozzle needed for printing the line i is defective, so that the dots at the pixel positions (i, j-2) and (i, j) are missing. This would give rise to a perceptible brighter gap in the printed image at the position of the line i.

[0022] In order to eliminate or at least mitigate this image defect, the processing unit 24 shown in figure 1 performs a camouflage step which, in the given example, leads to the insertion of an additional dot 30 at the pixel position (i-1, j-1), i.e. in the pixel line i-1 directly adjacent to the defective line i. As a result, on a macroscopic scale the image shown in figure 2C resembles the ideal image shown in figure 2A.

[0023] This camouflage process will now be explained in detail. At first, it shall be assumed that the print data are supplied to the printer in a multi-level format, in which the grey value of each pixel is indicated by an 8-bit word, i.e. by an integral number between 0 and 255. The number 0 represents a white pixel and the number 255 a black pixel with maximum optical density. The print data are thus represented by a multi-level pixel matrix 32 as is schematically shown in figure 3. In the single-pass mode, each pixel line of this pixel matrix will be printed by only one of the nozzles 22 of the printhead. The printer may be equipped with a detection system which automatically detects and locates defective nozzles. As an alternative, the location of a defective nozzle may also be input by the user. When, for example, the nozzle responsible for printing the line i of the pixel matrix is defective, the pixels in the line i are non-printable pixels 34. These pixels have been left white in figure 3. Printable pixels 36 are indicated by a light hatching. When it is found that the line i cannot be printed, one or more adjacent lines i-1 and i+1 are defined as a camouflage area 38 which will be used for camouflaging the defect in line i. The printable pixels 38 are indicated by a frequent hatching and are part of the camouflage area 38.

[0024] As another example, figure 4 illustrates the case of a two-pass print mode, where two nozzles of the printhead are involved in printing the pixels of the same line. Thus, when one of the nozzles needed for printing of the line i is defective, half of the pixels will be a non-printable pixel 34, such as the pixels in columns j-3, j-1 and j+1 in figure 4. The camouflage area 38 may then be formed by the remaining printable pixels in line i (i. e. the pixels in columns j-2, j and j+2). Alternatively, the camouflage area 38 may also include the pixels in the two adjacent lines i-1 and i+1, as is shown in figure 4.

[0025] It is known in the art that the halftoning process and the printing process create a non-linear relation between the grey value gc as input and the optical density on receiving material as output. This non-linear relation is called gamma curve function. The non-linear relation is corrected in the art by means of a gamma correction function.

[0026] Figure 5 shows an example of a gamma curve 40 which specifies the relation between a grey value gc of the pixels as supplied to the halftoning process and the optical density OD with which the pixels will actually be printed on the recording medium. The curve 40 is the normal gamma curve of the printer, i.e. it pertains to the case that there is no nozzle defect.

[0027] In figure 6, the curve 42 represents a gamma correction function that is used for correcting the gamma curve 40 shown in figure 5, as is well known in the art. This correction function defines a relation between the original grey value g and the corrected grey value gc. The gamma correction function 42 is obtained by inverting the function represented by the gamma curve 40 such that a visually pleasing transfer curve is obtained. In the conventional gamma correction process, which is employed here for the printable pixels 36, the original grey value g of each pixel is subjected to the gamma correction function 42, and the result is a corrected grey value gc. Thus, a gamma-corrected pixel matrix is obtained in which each matrix element contains the corrected grey value gc of the corresponding pixel. This corrected pixel matrix is then subjected to a conventional halftoning process such as dithering or error diffusion, so that the corrected pixel matrix is converted into a bitmap in which each pixel as a binary value, either 0 for a white pixel or 1 for a black pixel. The halftoning process and printing process results in a relation between the corrected grey value gc and the optical density OD, which relation is represented by the gamma curve 40. Since the correctional function 42 is essentially inverse to the gamma curve 40, one finally obtains a practically linear relation between the original grey values g and the corresponding optical densities OD.

[0028] However, in the camouflage area 38 the resulting average optical density OD would be smaller, because the black pixels that have been placed in line i (in figure 3) in the halftoning process are missing in the printed image. This effect can be described by a modified gamma curve 44 that is shown in dotted lines in figure 5.

[0029] The shape of curve 44 depends on the spatial size with which the optical densities OD are sampled. In this example we suppose a sampling and camouflage region of 3 lines: the line i of the defective nozzle, and the lines i+1 and i-1 directly adjacent to it. This result in a modified gamma curve 44 corresponding to a factor 2/3 of curve 40 representing to the information that still will be printed. As will be explained later the inverse of this factor can be used in a correction routine. Similarly, if the camouflage region is 5 lines wide this factor is 4/5.

[0030] In order to camouflage the nozzle defect, a modified gamma correction curve 46, as shown in figure 6, is used for gamma correction in the camouflage area 38. If, for example, a pixel in the original print data has the grey value g1, the modified gamma correction function 46 will yield the (modified) corrected grey value gc1. Now, the conventional halftoning process is performed without any further modifications for the pixels in the camouflage area 38. Since the (modified) corrected grey value gc1 is larger than the (not modified) corrected grey value gc1 (not depicted), this has the effect that additional black pixels are added in the camouflage area 38. The effect of the print process with the defective nozzle in line i is governed by the modified gamma curve 44. This curve links the corrected grey value gc1 to an optical density OD1 which is proportional to the original grey value g1 of the pixel. As a result, the nozzle defects in line i is camouflaged in the manner as shown in figure 2C.

[0031] As has been mentioned already, the grey value g1 for any pixel can only be in the range between 0 and 255. It should be noted however, that the corrected grey value gc1 may become larger than 255. When halftoning is achieved by error diffusion, for example, such larger values beyond 255 may well be processed and lead to the insertion of additional black pixels.

[0032] The camouflage process described above is particularly efficient for images which mainly contain small or medium grey levels. In case of very dark images and, in the extreme, in the case of solid black areas, it is increasingly difficult or even impossible to add more black pixels in the camouflage area. Nevertheless, the camouflage process may be useful even for dark or black images, depending upon the design of the printer. Some known printers are capable of printing a plainly black area even when the percentage of black pixels in the bitmap is somewhat smaller than 100%. In this case, the modified gamma correction in the camouflage area 38 may lead to an over-saturated bitmap which would still mask the nozzle defect to some extent.

[0033] The appropriate form of the modified gamma correction curve 46 will generally depend on several physical parameters such as the size of ink droplets produced by the printhead, the resolution of the printer, the spreading of the ink on the recording paper and the like. Obviously, the correction function will also depend on the print mode and on the definition of the camouflage area. For example, in figure 3, where the single-pass mode is employed and the camouflage area 38 is formed by the two lines directly adjacent to the defective line. For this example, in a simplified approach, a suitable modified gamma correction function may also be obtained by multiplying the regular gamma correction function 42 with a predetermined factor of 3/2. In case of one line directly adjacent to the defective line a suitable modified correction function is obtained by for example multiplying the regular gamma correction function 42 with a predetermined factor 2.

[0034] In the two-pass mode shown in figure 4, the factor for modifying the gamma correction function would be 6/5, when the adjacent lines i+1, i-1 and half of the pixels of line i are included in the camouflage area 38. When the camouflage area only consists of the printable pixels in the line i, the factor would be 2.

[0035] In a more elaborated embodiment, the correction curve 46 may be determined on the basis of a direct measurement of the corresponding gamma curve 44 by disabling one of the nozzles of the printer and measuring the optical density of the printed image for different grey levels of the original image.

[0036] A specific embodiment of the method according to the invention will now be described by reference to the flow diagram shown in figure 7. In step S100 the multi-level pixel matrix 32 is established by reading the grey values g. The pixel lines that are affected by nozzle failures of the printhead are identified in step S101. Then, in step S102, the camouflage area 38 surrounding these pixel lines is determined. Step S103 consists of a conventional gamma correction for all the pixels of the pixel matrix on the basis of the regular gamma correction function 42. In this step, the corrected grey values gc corresponding to the original grey value g of each pixel are calculated or looked-up in a table. For all the pixels in the camouflage area 38 the corrected grey values gc are modified in step S104 by multiplying the corrected grey values gc with a predetermined factor, whereas the values gc for the printable pixels 36 are left as they are. This step results for all the pixels in the camouflage area 38 to a shift from the gamma correction function 42 to the modified gamma correction function 46. Step S105 is a conventional halftone step, e.g. dithering or error diffusion, and leads to the insertion of black pixels in the camouflage area 38. The resulting bitmap is then printed in step S106.

[0037] Alternatively, the step S100 may be performed after the step S101 or even after the step S102. Then, the grey values for the non-printable pixels 34 need not be read, because they are not utilised in the further process.

[0038] In another embodiment it is possible to combine step 103 and 104 for the camouflage area. This effectively results in an identical data flow for the whole image, in which only the function gc(g) is different in the camouflage area than outside the camouflage area.

[0039] An alternative for step S104 in figure 7 is that the modified gamma correction function is determined by a measuring method. The modified gamma function can be determined the same way as the gamma function, except the method applies to print optical density areas with a simulated defective print element comprising the following steps:

> make a digital chart with optical density areas, each area has a different
> optical density, print this chart with a simulated defective print element,
> measure the optical densities of the areas of this chart, determine the modified gamma function 44, and determine the modified gamma correction function 46.

[0040] Figure 8 illustrates another embodiment which is adapted to the case that the print data are presented already in the format of a bitonal bitmap, i.e. a matrix of only black and white pixels. The bitmap is read in step S200. The steps S201 and S202 correspond to the steps S101 and S102 discussed above. It is assumed here that the bitmap data read in step S200 have already been subjected to a regular gamma correction in the process in which the bitmap has been established. Thus, a regular gamma correction step corresponding to the step S103 in figure 7 is omitted in the embodiment of figure 8. In step S204 the bitmap is reconverted into a multi-level pixel matrix. To this end, a value of 255+n is assigned to each of the black pixels of the pixel matrix, i.e. the pixels having the binary value 1, and the white 0-pixels are left as they are. Here, n is an integral number that has been appropriately selected to represent the shift from the regular gamma correction curve 42 to the modified curve 46. The number n may be constant or may be varied in accordance with the average grey level in a pixel cluster surrounding the pertinent pixel in the camouflage area. The multi-level pixel matrix thus obtained in step S204 is then transformed again into a bitmap by error diffusion in step S205, and the resulting bitmap is printed in step S206.

[0041] The embodiment of figure 8 has been exemplified for the single-pass mode, but it goes without saying that this method is also applicable to a multi-pass mode, as has been described in conjunction with figure 4.

[0042] Figure 9A shows an example of the bitmap read in step S200. Again, it is assumed that the nozzle that is responsible for printing the pixels in line i in the single-pass mode is defective. Figure 9 illustrates the corresponding multi-level pixel matrix 50 obtained in step S204 with n = 128. Figure 9C shows the final bitmap or binary pixel image 52 resulting from the error diffusion step S205. In this simplified example, error diffusion is performed by carrying the error from one pixel only to the next pixel in the same line. For example, the corrected grey value gc of the black pixel (i+1, j-1) is 383, which is larger than the threshold value of 255. This gives a black pixel "1" in figure 9C, and the threshold value of 255 is subtracted from 383. The rest (i. e. 128) is carried to the next pixel (i+1, j). Since this rest is smaller than the threshold value, this pixel is left white ("0"), and the rest is carried-on to the next pixel and then to the pixel (i+1, j+2). Here, the accumulated error is 511, which is larger than 255, so that this pixel is made black. The rest of 256 is carried to the next pixel which in this case is the first pixel in the next line of the camouflage area, i.e.. the pixel (i-1, j-3). This pixel is made black, and the rest (384) is carried to the next pixel (i-1, j-2) which gives an additional black pixel in this position. The rest is carried through the subsequent pixels and finally results in another additional black pixel in the position (i-1, j+2). Thus, in this example, two new pixels are added in line i-1 in order to camouflage the defect in line i.

Claims

1. A printing method for a printer having a printhead with a plurality of print elements and capable of printing a binary pixel image, the method comprising the steps of:

   a) locating a defective print element,
   b) determining a camouflage area in the vicinity of pixels that would have to be printed with the defective print element and
   c) camouflaging defective print element by modifying image information in said camouflage area,

   characterised in that step c) comprises the steps of:

   modifying (S104; S204) a gamma correction function (42) to a modified gamma correction function (46) and
   using said modified gamma correction function (46) in said camouflage area.

2. The method of claim 1, wherein the method comprises
   printing the binary pixel image in a single-pass mode and
   forming the camouflage area (38) by at least one pixel line directly adjacent to a pixel line (i) that cannot be printed because of the defective print element.

3. The method of claim 1, wherein the method comprises
   printing the binary pixel image in a multi-pass mode and
   forming the camouflage area (38) by at least pixels that can be printed of a pixel line (i) that partly cannot be printed because of the defective print element.

4. The method of one of the preceding claims, wherein step c) results in a multi-level pixel matrix (32; 50) and is followed by a halftoning step (S105; S205) in which the pixel matrix is converted into the binary pixel image.

5. The method of claim 4, wherein the halftoning step (S105; S205) for said camouflage area (38) ignores the image information of the pixels (34) that cannot be printed because of the defective print element.

6. The method of claim 4 or 5, wherein the halftoning step (S105; S205) is an error diffusion step in which the error diffusion skips those pixels (34) that cannot be printed because of the defective print element.

7. The method of one of the claims 1 to 6, wherein said gamma correction step includes a first substep

(S103) of a regular gamma correction for at least the printable pixels (36) outside of the camouflage area (38), said first substep comprising the conversion of multi-level grey values (g) into corrected grey values (gc) on the basis of the gamma correction function (42) that is adapted to a non-defective printer; and a second substep (S104) comprising the conversion of the multi-level grey values (g) of the pixels in the camouflage area (38) into the corrected grey values (gc) on the basis of the modified gamma correction function (46) that applies to the defective printer.

8. The method of claim 7, wherein the first substep (S103) is performed for all the pixels of the image, possibly with the exception of the non-printable pixels (34), and the second substep (S104) is performed by multiplying the corrected grey values (gc) obtained in the first substep with a predetermined factor.

9. The method of claim 7, wherein the first substep (S103) is performed for all the pixels of the image, with the exception of the camouflage area (38), and the second substep (S104) is performed with the modified gamma correction function (46) which is derived from a measurement determining the modified gamma function (44).

10. The method of one of the claims 1 to 6, wherein print data are received in the form of a first binary pixel image (48) and are converted into the multi-level pixel matrix (50) for step c) (S204) and the resulting pixel matrix is then reconverted into a second binary pixel image (52) by error diffusion.

11. The method of claim 10, wherein the first binary pixel image (48) is converted into said multi-level pixel matrix (50) by assigning a value representing white to all the white pixels and assigning a predetermined value that corresponds to a threshold value for the error diffusion process to all black pixels and step c) is performed by changing said predetermined value assigned to the black pixels by a number (n).

12. A printer capable of printing a binary pixel image, **characterised by** a processing unit (24) in which a method of one of the claims 1 to 11 is implemented.

13. A computer program to execute the method according to one of the claims 1 to 11 comprising computer program code to make a processing unit (24) which forms part of or is connectable to a printer.

14. A computer program comprising code means that when executed on a computer carry out all steps of one of the claims 1 to 11.

Fig. 1

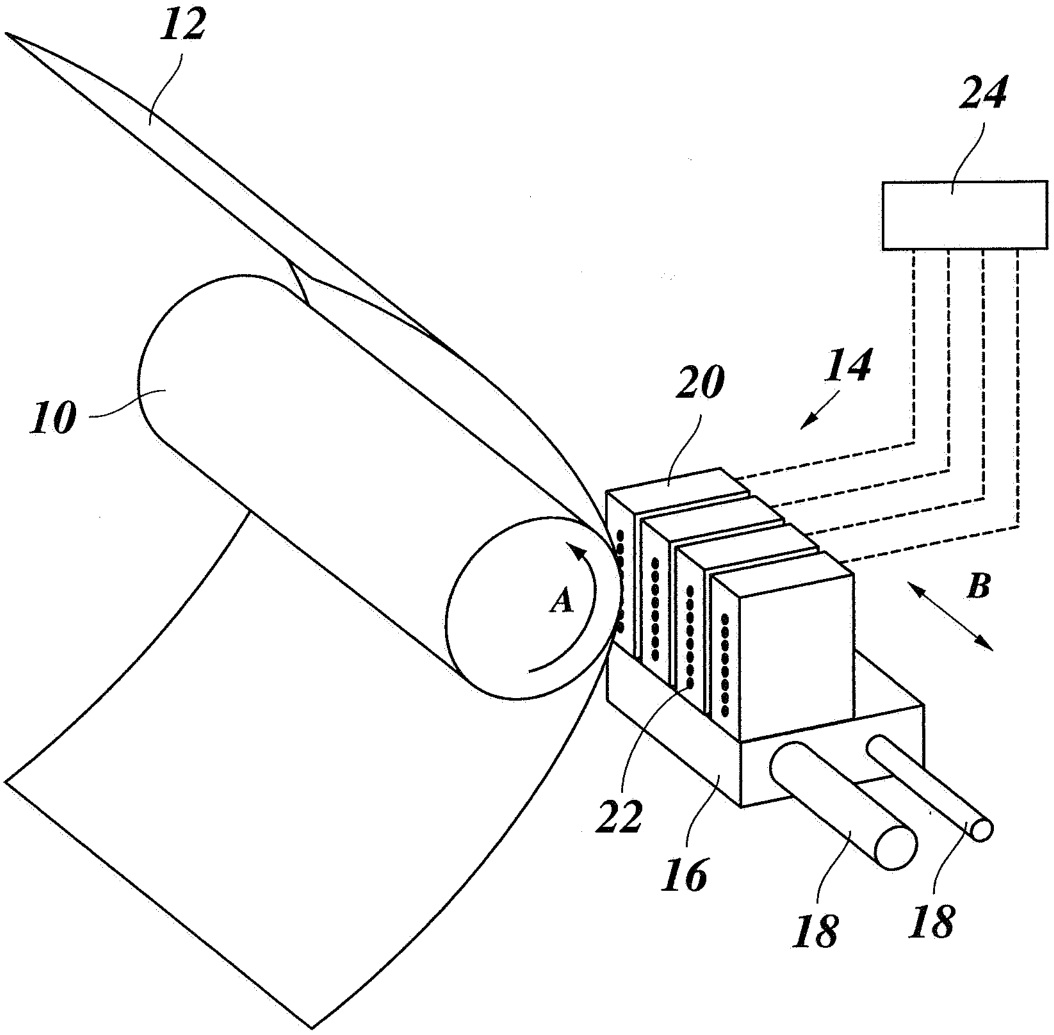


Fig. 2A

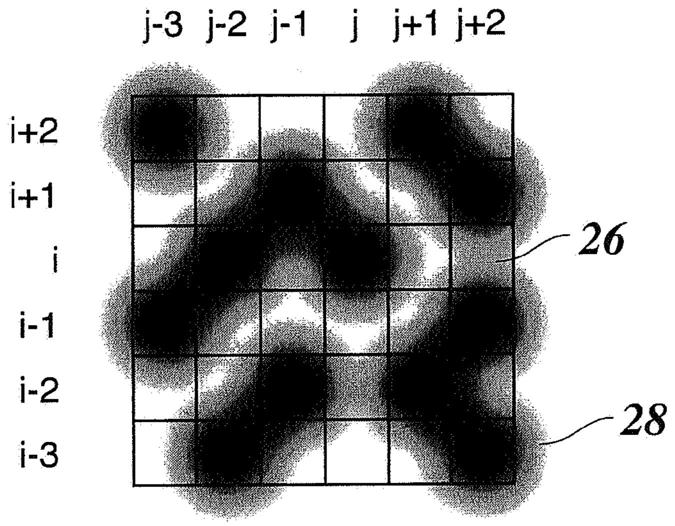


Fig. 2B

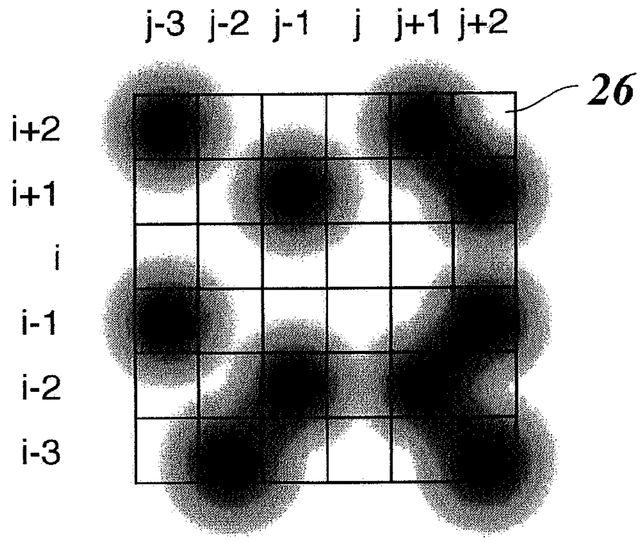


Fig. 2C

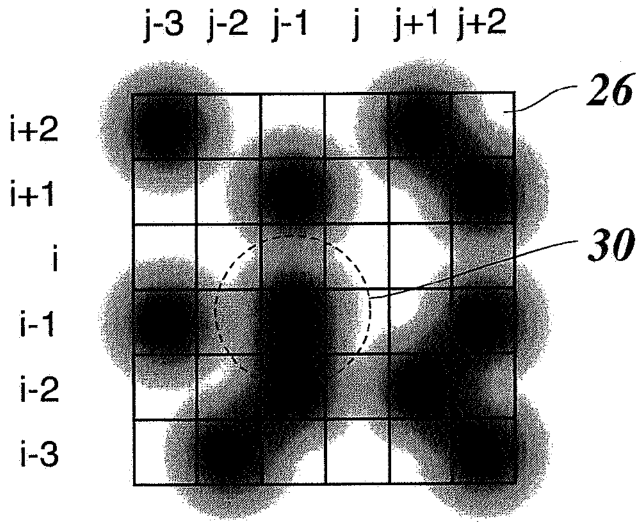


Fig. 3

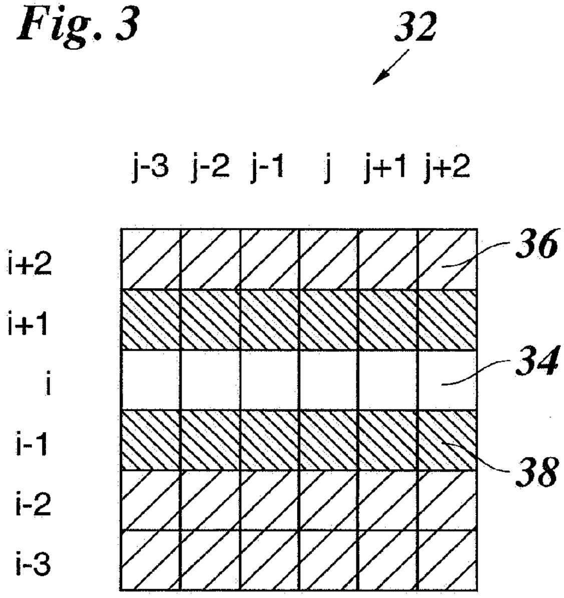


Fig. 4

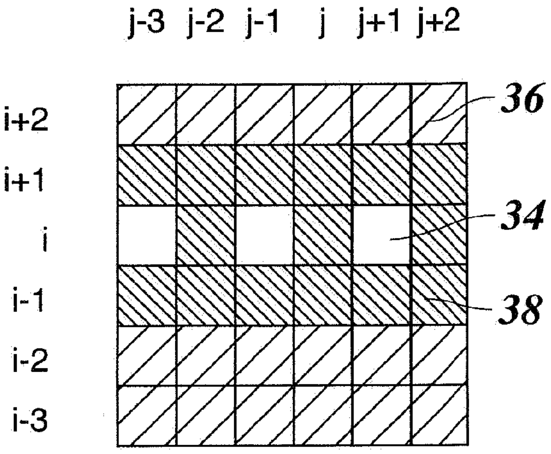


Fig. 5

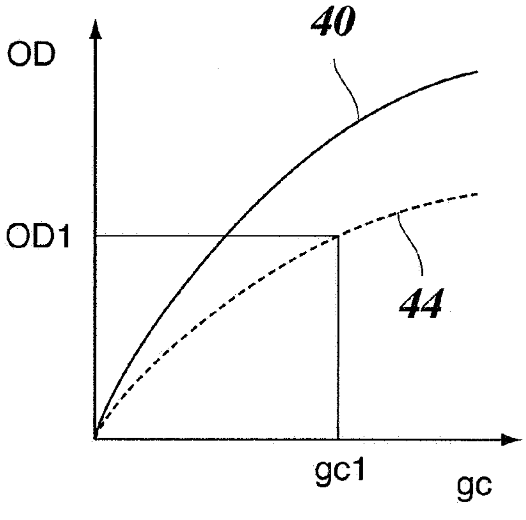


Fig. 6

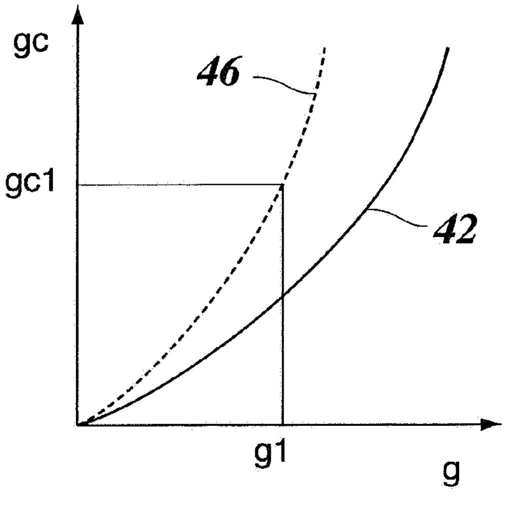


Fig. 7

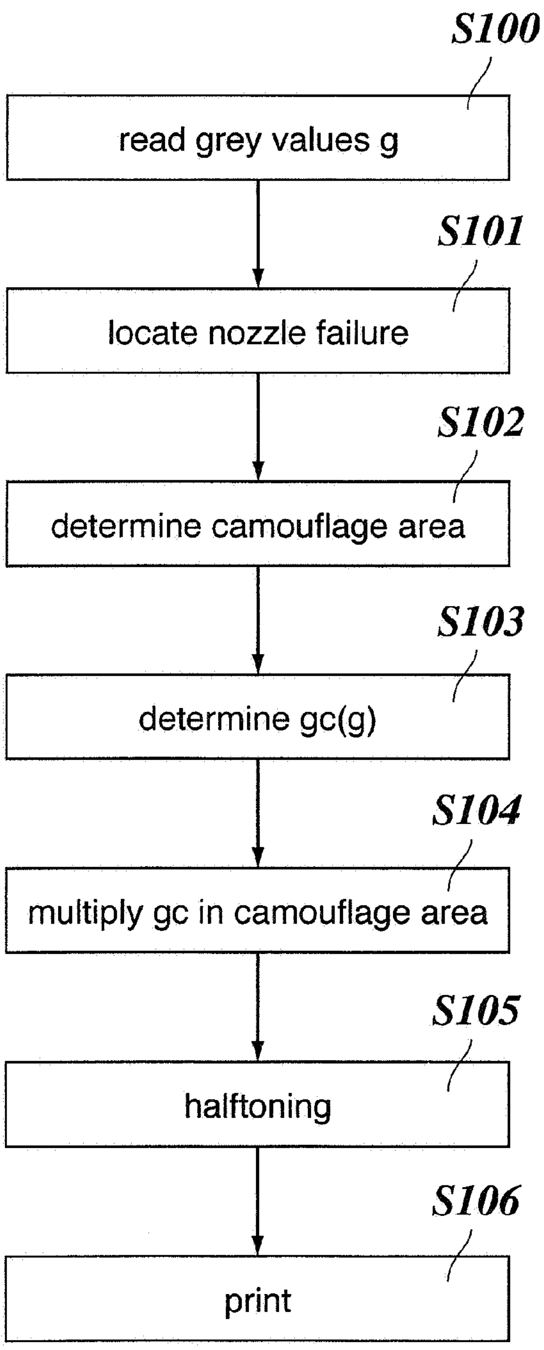

S100
read grey values g
S101
locate nozzle failure
S102
determine camouflage area
S103
determine gc(g)
S104
multiply gc in camouflage area
S105
halftoning
S106
print

Fig. 8

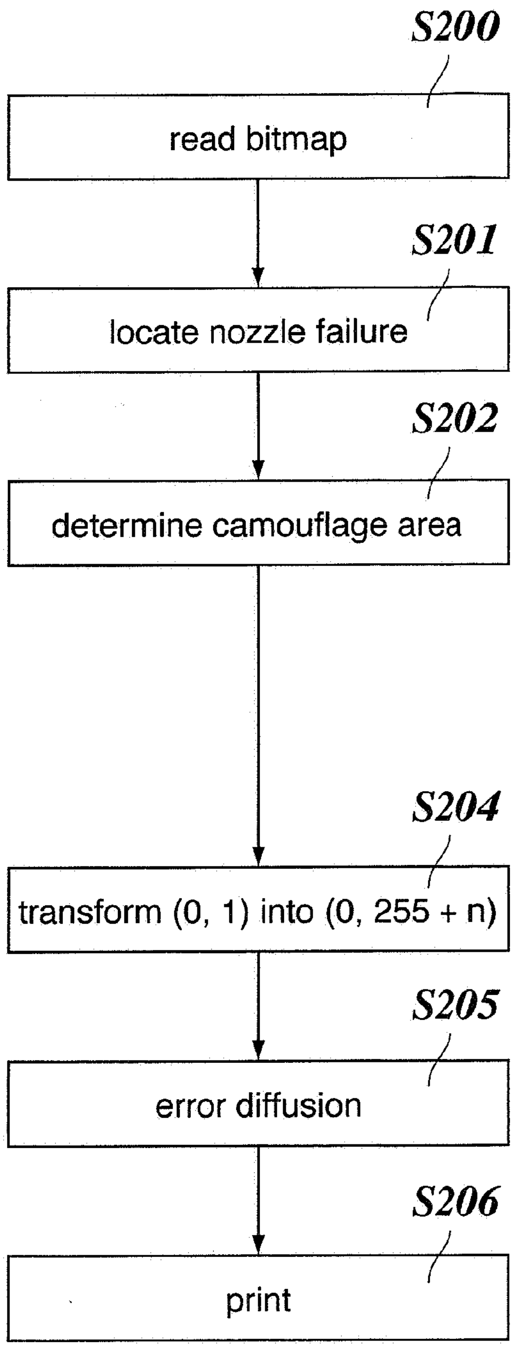
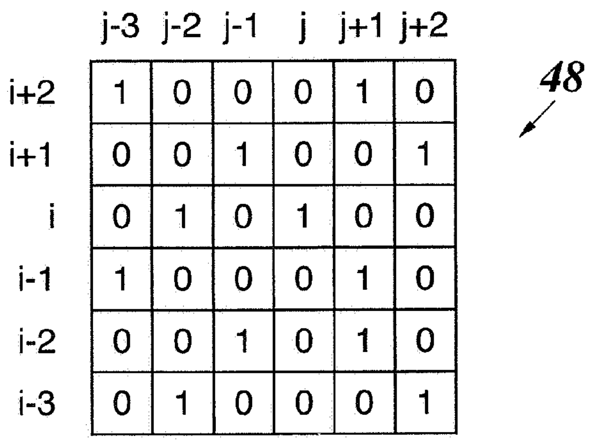
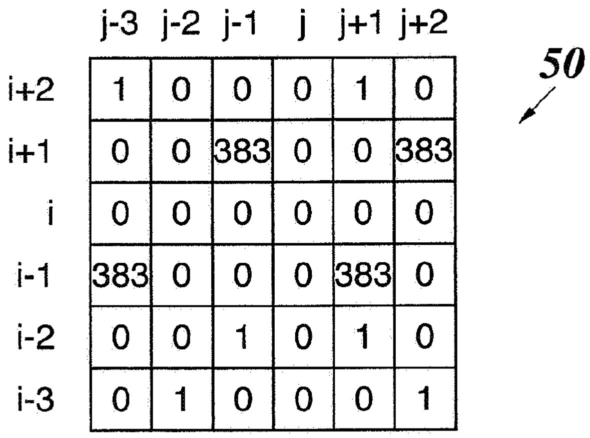

S200
read bitmap
S201
locate nozzle failure
S202
determine camouflage area
S204
transform (0, 1) into (0, 255 + n)
S205
error diffusion
S206
print

Fig. 9A



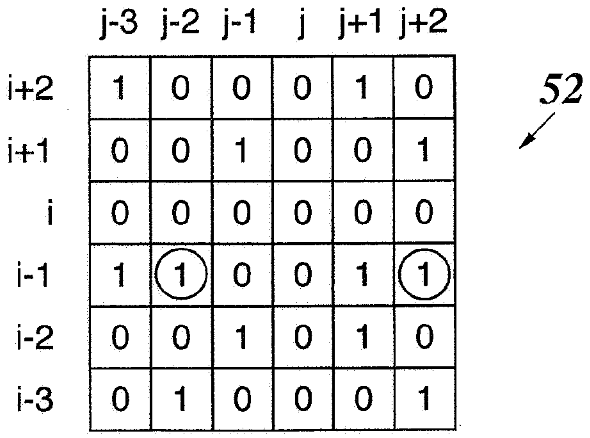
	j-3	j-2	j-1	j	j+1	j+2
i+2	1	0	0	0	1	0
i+1	0	0	1	0	0	1
i	0	1	0	1	0	0
i-1	1	0	0	0	1	0
i-2	0	0	1	0	1	0
i-3	0	1	0	0	0	1

Fig. 9B



	j-3	j-2	j-1	j	j+1	j+2
i+2	1	0	0	0	1	0
i+1	0	0	383	0	0	383
i	0	0	0	0	0	0
i-1	383	0	0	0	383	0
i-2	0	0	1	0	1	0
i-3	0	1	0	0	0	1

Fig. 9C



	j-3	j-2	j-1	j	j+1	j+2
i+2	1	0	0	0	1	0
i+1	0	0	1	0	0	1
i	0	0	0	0	0	0
i-1	1	①	0	0	1	①
i-2	0	0	1	0	1	0
i-3	0	1	0	0	0	1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 10 4428

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	* paragraph [0007] * -----		
D,A	US 6 215 557 B1 (OWENS BRIAN KEITH) 10 April 2001 (2001-04-10) * column 4, line 27 - line 37 * * column 5, line 26 - line 67 * -----	1-14	

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B41J
H04N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 March 2005	De Groot, R

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