US 20160170359A1

(19) United States
(12) Patent Application Publication
(10) Pub. No.: US 2016/0170359 A1
(43) Pub. Date: Jun. 16, 2016
Itoh

(54) **IMAGE FORMING APPARATUS**

(71) Applicant: **CANON KABUSHIKI KAISHA**, Tokyo (JP)

(72) Inventor: **Jun Itoh**, Kashiwa-shi (JP)

(21) Appl. No.: **14/963,548**

(22) Filed: **Dec. 9, 2015**

(30) **Foreign Application Priority Data**

Dec. 12, 2014 (JP) 2014-252060

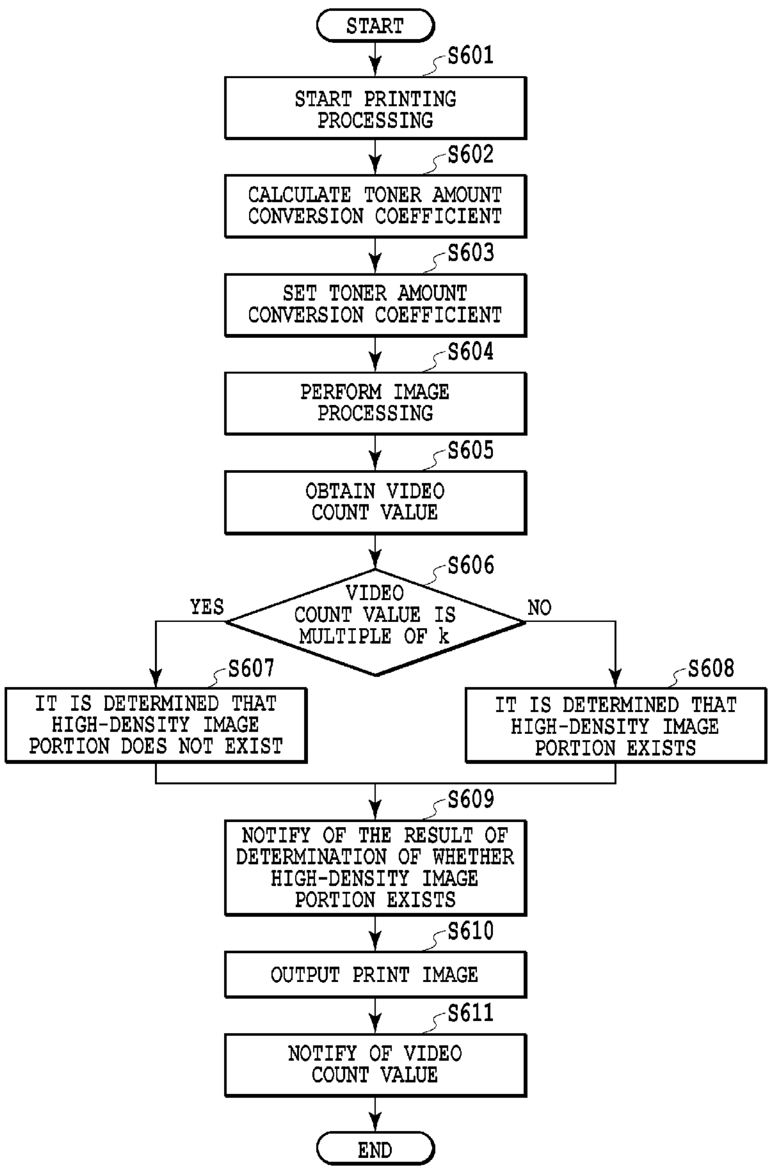
Publication Classification

(51) **Int. Cl.**
G06F 3/12 (2006.01)

(52) **U.S. Cl.**
CPC *G03G 15/556* (2013.01)

(57) **ABSTRACT**

An image forming apparatus having a hardware configuration for counting the amount of toner used for an image to be printed for each color component uses a conversion coefficient used for processing for converting a pixel value in image data expressing the image into a signal value indicating the amount of toner to convert the pixel value into the signal value. The image forming apparatus outputs information indicating whether or not a high-density image portion is included in an image based on the signal value obtained by performing the conversion.



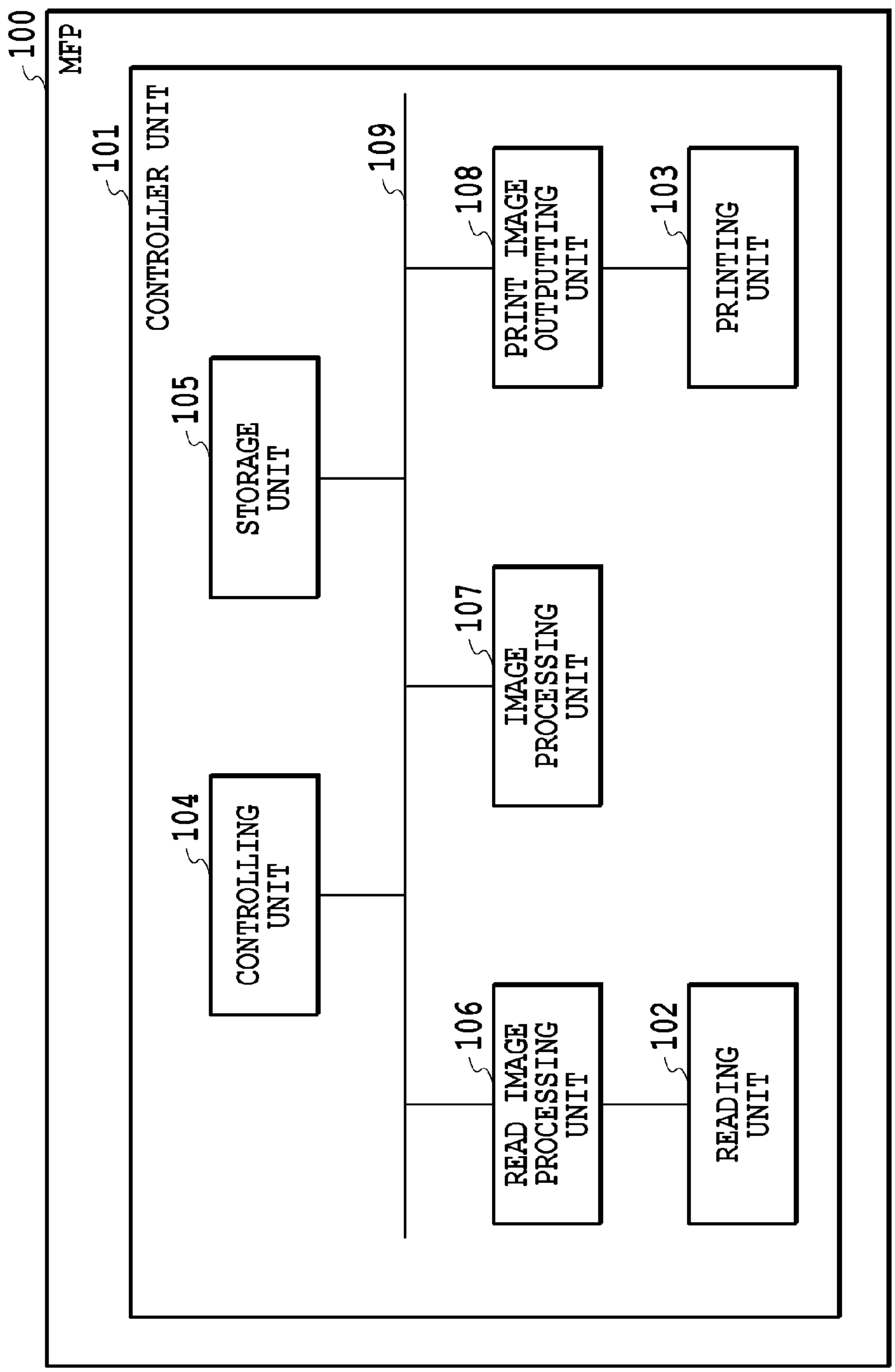

100
MFP
101
CONTROLLER UNIT
109
104
CONTROLLING UNIT
105
STORAGE UNIT
106
READ IMAGE PROCESSING UNIT
107
IMAGE PROCESSING UNIT
108
PRINT IMAGE OUTPUTTING UNIT
102
READING UNIT
103
PRINTING UNIT

FIG.1

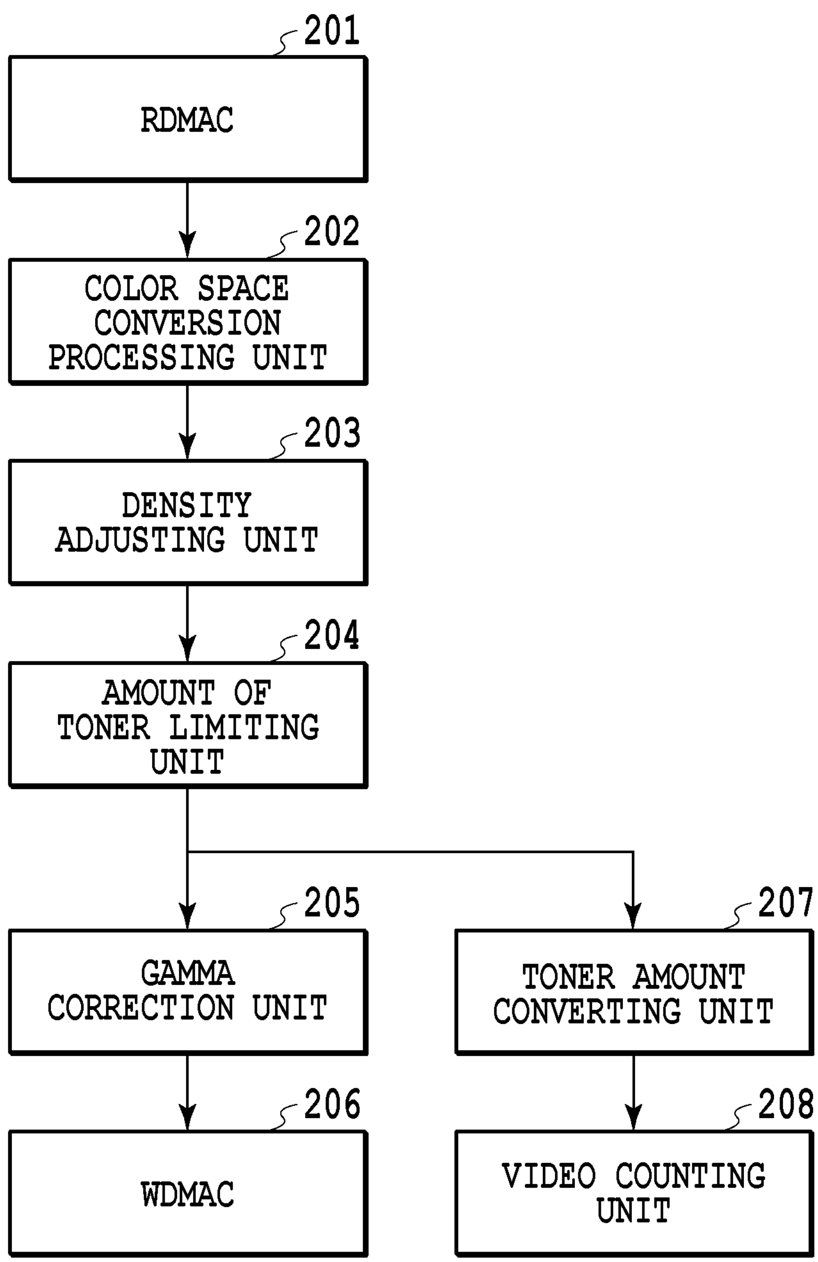

201
RDMAC
202
COLOR SPACE CONVERSION PROCESSING UNIT
203
DENSITY ADJUSTING UNIT
204
AMOUNT OF TONER LIMITING UNIT
205
GAMMA CORRECTION UNIT
207
TONER AMOUNT CONVERTING UNIT
206
WDMAC
208
VIDEO COUNTING UNIT

FIG.2

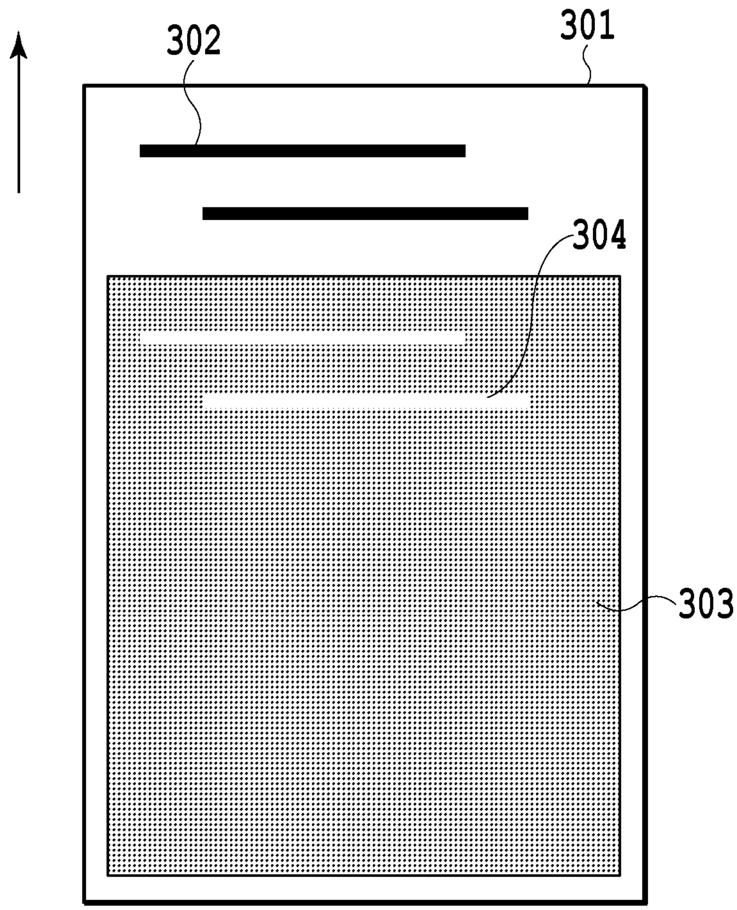


FIG.3

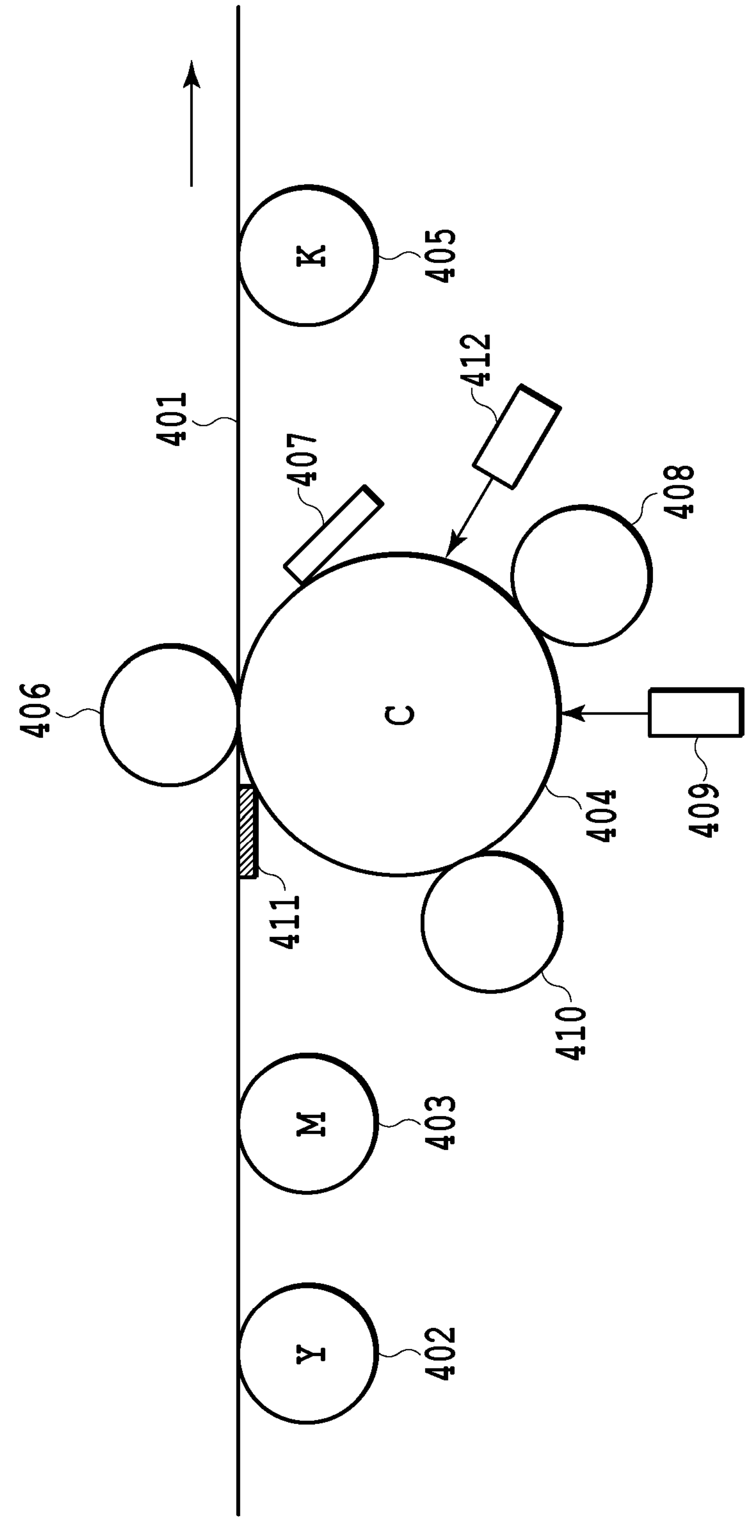


FIG.4

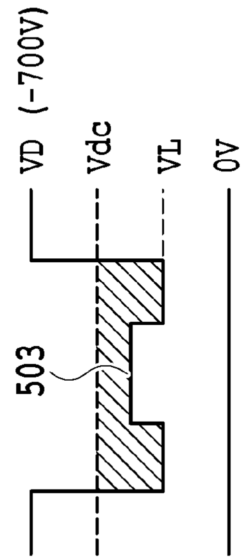


FIG.5C

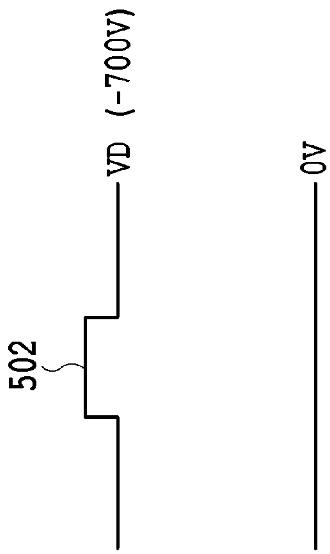


FIG.5B

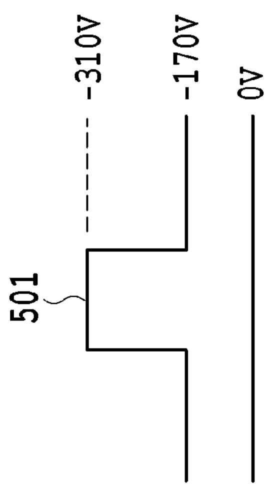


FIG.5A

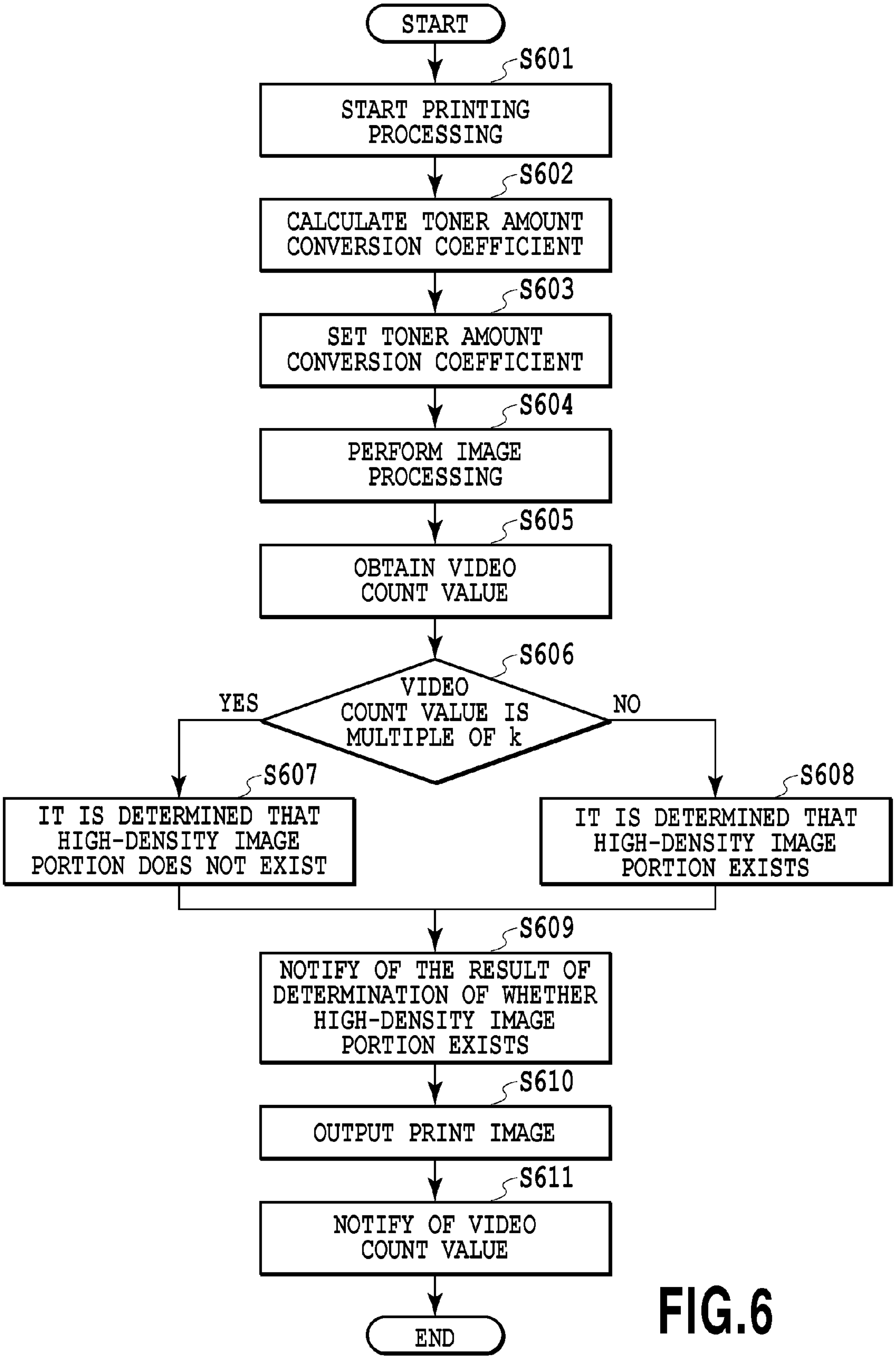

START
S601
START PRINTING PROCESSING
S602
CALCULATE TONER AMOUNT CONVERSION COEFFICIENT
S603
SET TONER AMOUNT CONVERSION COEFFICIENT
S604
PERFORM IMAGE PROCESSING
S605
OBTAIN VIDEO COUNT VALUE
S606
VIDEO COUNT VALUE IS MULTIPLE OF k
YES
NO
S607
IT IS DETERMINED THAT HIGH-DENSITY IMAGE PORTION DOES NOT EXIST
S608
IT IS DETERMINED THAT HIGH-DENSITY IMAGE PORTION EXISTS
S609
NOTIFY OF THE RESULT OF DETERMINATION OF WHETHER HIGH-DENSITY IMAGE PORTION EXISTS
S610
OUTPUT PRINT IMAGE
S611
NOTIFY OF VIDEO COUNT VALUE
END

FIG.6

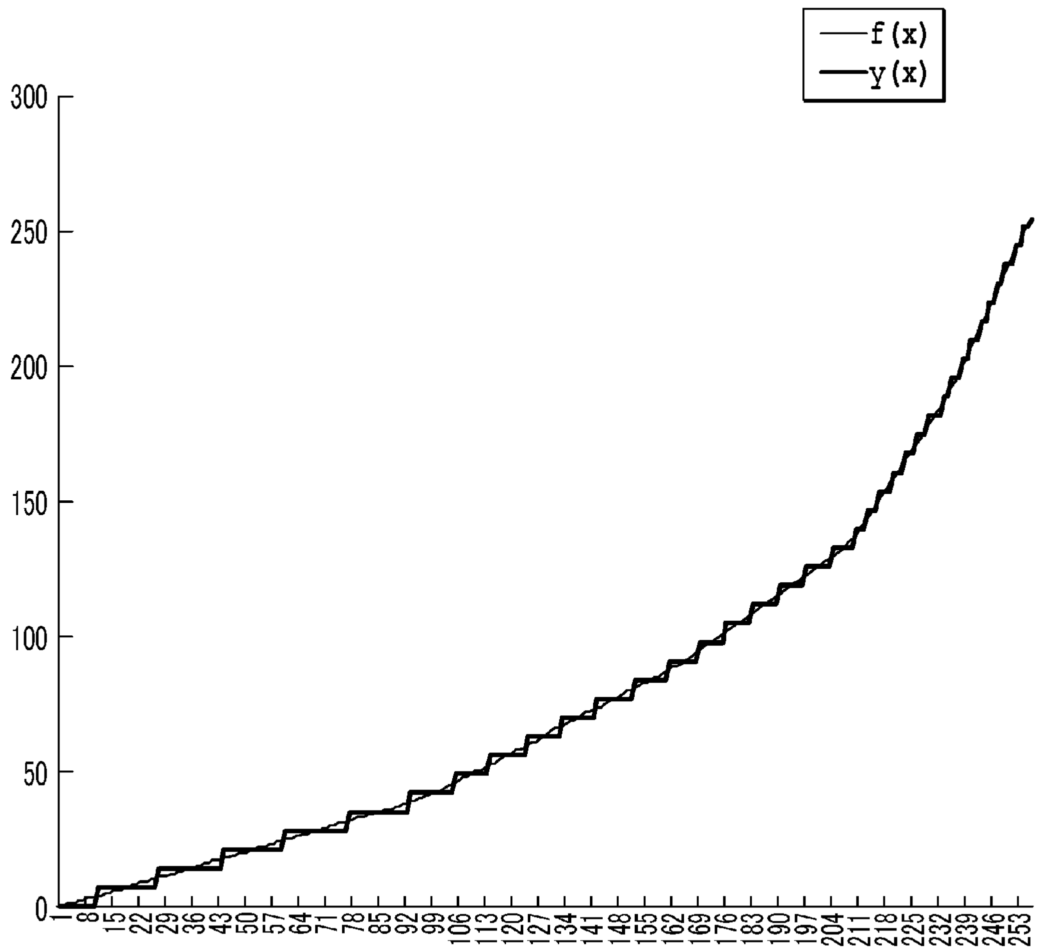

f(x)
y(x)
300
250
200
150
100
50
0
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
113
120
127
134
141
148
155
162
169
176
183
190
197
204
211
218
225
232
239
246
253

FIG.7

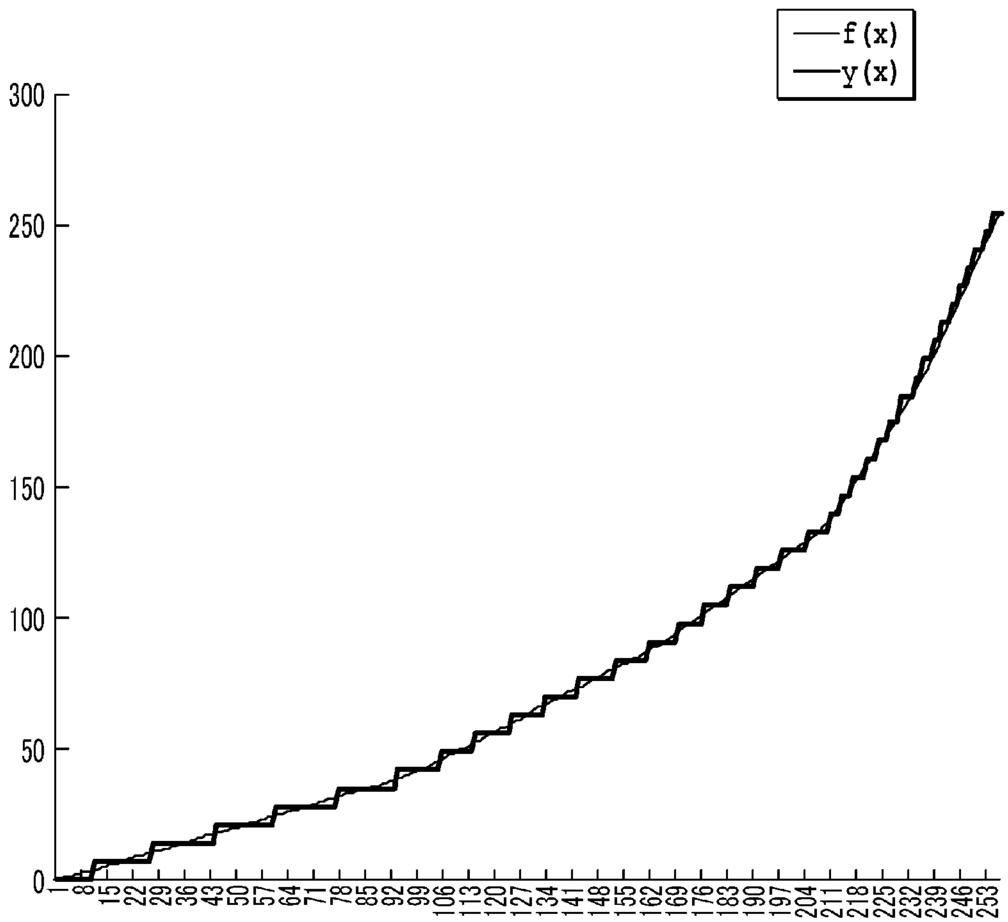

f(x)
y(x)
300
250
200
150
100
50
0
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
113
120
127
134
141
148
155
162
169
176
183
190
197
204
211
218
225
232
239
246
253

FIG.8

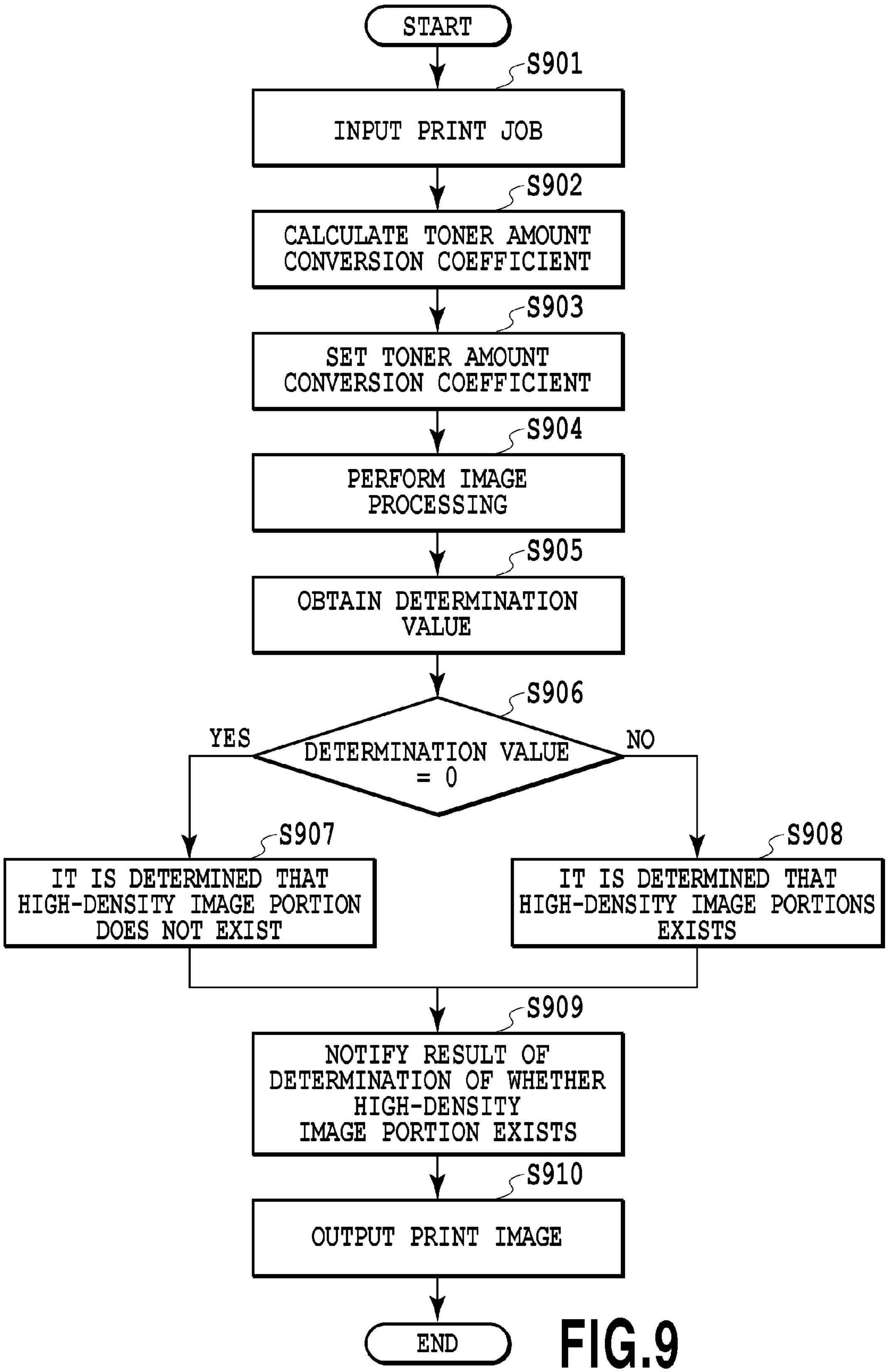

START
S901
INPUT PRINT JOB
S902
CALCULATE TONER AMOUNT CONVERSION COEFFICIENT
S903
SET TONER AMOUNT CONVERSION COEFFICIENT
S904
PERFORM IMAGE PROCESSING
S905
OBTAIN DETERMINATION VALUE
S906
DETERMINATION VALUE = 0
YES
NO
S907
IT IS DETERMINED THAT HIGH-DENSITY IMAGE PORTION DOES NOT EXIST
S908
IT IS DETERMINED THAT HIGH-DENSITY IMAGE PORTIONS EXISTS
S909
NOTIFY RESULT OF DETERMINATION OF WHETHER HIGH-DENSITY IMAGE PORTION EXISTS
S910
OUTPUT PRINT IMAGE
END

FIG.9

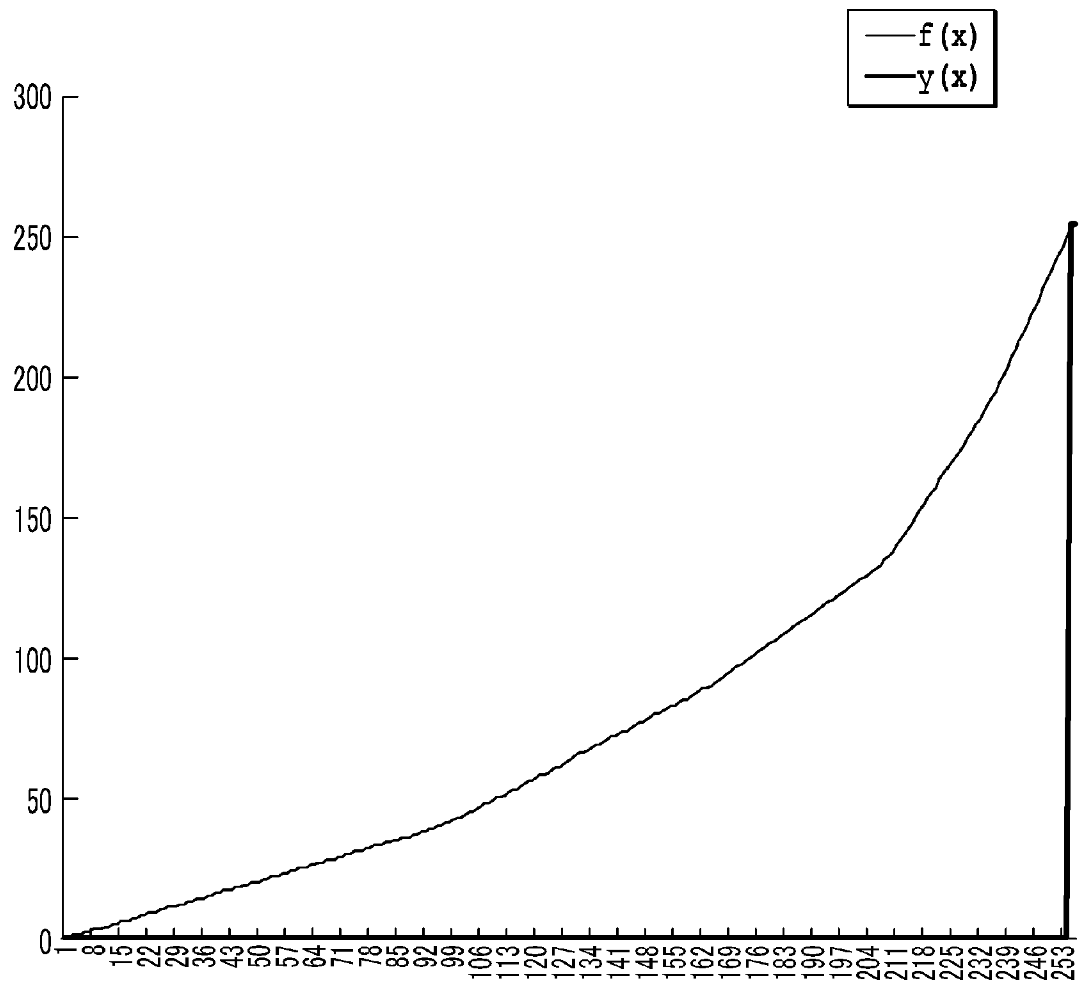

f(x)
y(x)
300
250
200
150
100
50
0
1 8 15 22 29 36 43 50 57 64 71 78 85 92 99 106 113 120 127 134 141 148 155 162 169 176 183 190 197 204 211 218 225 232 239 246 253

FIG.10

IMAGE FORMING APPARATUS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to an image forming apparatus using an electrophotographic system such as a copying machine, a printer, or a multifunction peripheral (MFP).

[0003] 2. Description of the Related Art

[0004] An image forming apparatus using an electrophotographic system, an electrostatic recording system, or the like charges the surface of an image carrier such as a photosensitive drum to a predetermined potential. An electrostatic latent image is formed on the charged surface of the image carrier, and this electrostatic latent image is developed to form a toner image on the surface of the image carrier. The toner image formed in this manner is transferred by a transfer unit such as a transfer roller from the surface of the image carrier to a printing material (an output sheet) or an intermediate transfer body. As the image forming apparatus, there is conventionally known a so-called tandem structure in which a plurality of the image carriers corresponding to respective toner colors are arranged in a direction in which the printing material or the intermediate transfer body is conveyed.

[0005] In the image forming apparatus in which the plurality of image carriers are arranged, there is a case that the development contrast of a toner image transferred by a succeeding image carrier differs between a portion of the printing material (or the intermediate transfer body) to which a toner image is transferred by a preceding image carrier and a portion of the printing material (or the intermediate transfer body) to which a toner image is not transferred by the preceding image carrier. As a result, there may occur a phenomenon called "a transfer memory" in which density unevenness appears in one image. This "transfer memory" will be described in detail.

[0006] For example, in an image forming process using negative toner (negatively charged toner) and employing a reverse developing method, a charging unit (a charging roller) uniformly charges the surface of a photosensitive drum to a dark part potential VD. Then an exposing unit emits image exposure light to the photosensitive drum according to an image density to change the potential of part of the surface of the photosensitive drum to a bright part potential VL, whereby contrast between the dark part potential VD and the bright part potential VL forms an electrostatic latent image. A developing unit applies a developing bias Vdc to the formed electrostatic latent image. A development contrast which is a development potential difference between the developing bias Vdc and the bright part potential VL forms a toner image on a portion having the bright part potential VL of the surface of the photosensitive drum.

[0007] The toner image is transferred from the photosensitive drum to the printing material or the intermediate transfer body by applying a positive (positive-polarity) transfer bias Vt to the transfer unit (the transfer roller). On this occasion, in a case where toner transferred from the preceding photosensitive drum is already present in the printing material or the intermediate transfer body, the toner functions as a resistor, and a transfer current does not easily pass through from the transfer roller to the succeeding photosensitive drum. Accordingly, the absolute value of the potential of the succeeding photosensitive drum at a position where the transferred toner exists is higher than that of the succeeding photosensitive drum at another position. In a case where a potential difference is too large before charging by the charging roller, the charging roller cannot remove the potential difference completely, the potential does not become uniform after charging by the charging roller, the absolute value of the potential becomes higher than the dark part potential VD, and accordingly, even at the time of forming an electrostatic latent image by using the exposing unit, the absolute value of the potential becomes higher than the bright part potential VL. A development potential difference between the high absolute value of the potential and the developing bias Vdc at the time of forming the toner image by using the developing unit becomes smaller than an original development potential difference between the developing bias Vdc and the bright part potential VL. Accordingly, the amount of toner and the density become small as compared with another portion. As a result, the effect of toner transferred from the preceding photosensitive drum appears as "the transfer memory" in the image formed after the succeeding photosensitive drum rotates one round. On this occasion, as the amount of toner which has been transferred to the printing material or the intermediate transfer body becomes larger, "the transfer memory" is more likely to occur.

[0008] With respect to this "transfer memory," there is known a method for reducing "the transfer memory" by emitting uniform exposure light to the photosensitive drum to perform "pre-exposure" for making uniform the potential of the photosensitive drum before the charging unit (the charging roller) charges the photosensitive drum to the dark part potential VD.

[0009] Further, Japanese Patent Laid-Open No. 2005-250387 discloses a method for changing a voltage used for charging a photosensitive drum to a voltage value for reducing "the transfer memory" in a case where it is determined that an image having a large amount of toner and a high density is included.

[0010] Reduction of "the transfer memory" with "pre-exposure" adversely affects the life of the photosensitive drum, and accordingly, it is not preferable to perform "pre-exposure" during processing for printing all images. Therefore, only in the case of printing an image including an image having a large amount of toner and a high density, it is requested to perform "pre-exposure." Japanese Patent Laid-Open No. 2005-250387 discloses a technique of reducing "the transfer memory" by determining whether or not a high-density image is included. However, in a case where there is no image processing hardware for detecting a high-density image, it is impossible to determine whether or not a high-density image is included. Further, in a case where there is separately mounted software or hardware for detecting a high-density image, the speed of printing processing is lowered.

SUMMARY OF THE INVENTION

[0011] In an aspect of the present invention, there is provided an image forming apparatus having a counting unit configured to count an amount of toner used for an image to be printed for each color component, the image forming apparatus comprising: a setting unit configured to set a conversion coefficient used for processing for converting a pixel value in image data expressing the image into a signal value indicating the amount of toner; a converting unit configured to convert the pixel value into the signal value by using the set conversion coefficient; and an outputting unit configured to output information indicating whether or not a high-density image portion is included in the image based on the signal value obtained by performing the conversion.

[0012] Further features of the present invention will become apparent from the following description of exemplary embodiments (with reference to the attached drawings).

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1** is a diagram showing an example of the hardware configuration of an MFP according to an embodiment of the present invention;

[0014] FIG. **2** is a diagram showing an example of the hardware configuration of an image processing unit according to the embodiment of the present invention;

[0015] FIG. **3** is a view showing an example of an image in which "a transfer memory" appears;

[0016] FIG. **4** is a view showing an example of the structure of a printing unit according to the embodiment of the present invention;

[0017] FIGS. **5**A to **5**C are graphs for explaining an example of an image forming process according to the embodiment of the present invention;

[0018] FIG. **6** is a flowchart showing a flow of printing processing in an MFP according to the first embodiment of the present invention;

[0019] FIG. **7** is a graph showing an example of a parameter which is applied to the image processing unit according to the first embodiment of the present invention;

[0020] FIG. **8** is a graph showing an example of a parameter which is applied to the image processing unit according to a second embodiment of the present invention;

[0021] FIG. **9** is a flowchart showing a flow of printing processing in the MFP according to a third embodiment of the present invention; and

[0022] FIG. **10** is a graph showing an example of a parameter which is applied to the image processing unit according to the third embodiment of the present invention.

DESCRIPTION OF THE EMBODIMENTS

[0023] A mode for carrying out the present invention will be described below with reference to the drawings.

Embodiment 1

[0024] FIG. **1** is a diagram showing an example of the hardware configuration of a multifunction peripheral (MFP) **100**, which is an image forming apparatus of Embodiment 1. The MFP **100** includes a controller unit **101**, a reading unit **102**, and a printing unit **103**. Further, the controller unit **101** includes a controlling unit **104**, a storage unit **105**, a read image processing unit **106**, an image processing unit **107**, a print image outputting unit **108**, and an internal bus **109**.

[0025] In FIG. **1**, the reading unit **102** has the function of scanning a document to obtaining image data. The printing unit **103** has the function of printing an image on a printing medium such as a sheet. The controlling unit **104** is a processor for collectively controlling the controller unit **101** of the MFP **100**, and controls each unit connected via the internal bus **109**. The storage unit **105** is a memory or a HDD, and stores various instructions (including application programs) to be executed by the controlling unit **104** to control the controller unit **101**. Further, the storage unit **105** temporarily stores image data scanned by the reading unit **102** and image data processed by the image processing unit **107**. The read image processing unit **106** performs image processing on the image data scanned by the reading unit **102**, and stores the image data in the storage unit **105**. The image processing unit **107** reads the image data stored in the storage unit **105**, and performs processing for converting an image into an image suitable for printing by the printing unit **103**. The print image outputting unit **108** reads the image data stored in the storage unit **105**, and transfers the image data to the printing unit **103**. In the printing unit **103**, photosensitive drums respectively corresponding to toners for four colors, that is, yellow (Y), magenta (M), cyan (C), and black (K) are arranged in a conveying direction in the order named.

[0026] FIG. **2** is a diagram showing an example of the hardware configuration of the image processing unit **107**. An RDMAC **201** is a direct memory access controller (DMAC) for controlling reading of image data from the storage unit **105**. Further, a WDMAC **206** is a DMAC for controlling writing of image data processed by the image processing unit **107** to the storage unit **105**. A color space conversion processing unit **202** converts brightness image data such as RGB read by the reading unit **102** and stored in the storage unit **105** into density image data suitable for printing of CMYK and the like. A density adjusting unit **203** converts the density of image data according to a parameter set in the controlling unit **104** for each printing processing operation. An amount of toner limiting unit **204** performs image conversion processing to restrict the maximum density value of image data according to the parameter set in the controlling unit **104** and the job type of image data. A gamma correction unit **205** performs image conversion processing to adjust the density of image data according to the state of the printing unit **103**. A toner amount converting unit **207** converts each pixel value in image data into a corresponding toner consumption amount in order to calculate the amount of toner consumed to print the image data by the printing unit **103**. A video counting unit **208** counts each pixel value in image data converted by the toner amount converting unit **207** and obtains the sum of the pixel values. Counting is performed for each of colors CMYK, the controlling unit **104** notifies the printing unit **103** of the result of counting, and the printing unit **103** uses the result of counting to control toner supply.

[0027] FIG. **3** is a view showing an example of an image in which "a transfer memory" appears. FIG. **3** shows an output sheet **301** on which image data is printed by the printing unit **103**, and an arrow shows a paper conveying direction. A high-density image portion **302** is an image portion in which toner is printed in up to a maximum limitation amount of toner. For example, the high-density image portion **302** is a red image having a density of 100%, and in this case, images of two colors, that is, yellow and magenta are printed at a density of 100%. A halftone image portion **303** is an image portion using a halftone and having a low density, and is, for example, a cyan halftone image. A transfer memory **304** is a transfer memory for the high-density image portion **302** which appears in the halftone image portion **303**, and there appear portions of the halftone image portion **303** having a density lower than that of the other portions of the halftone image portion **303** and having the same shape as the high-density image portion **302**. Further, a distance between the high-density image portion **302** and the transfer memory **304** is equal to the circumference of the photosensitive drum as explained later with respect to a mechanism of "the transfer memory." FIG. **3** shows an example in which the transfer memory appears in the same output sheet. However, in a case where the high-density image portion **302** is at a rear end of an output sheet with respect to the conveying direction, the transfer memory appears at a front end of a next output sheet.

[0028] FIG. **4** is a view schematically showing image formation by an electrophotographic process in the printing unit **103** according to the present embodiment. A toner image formed on the photosensitive drum is primarily transferred to an intermediate transfer belt **401** successively to form a full-color toner image. An arrow shows a conveying direction of the intermediate transfer belt. Further, the toner image formed on the intermediate transfer belt **401** is secondarily transferred to an output sheet, which is a printing sheet, by a secondary transfer unit (not shown). Photosensitive drums **402** to **405** are photosensitive drums (image carriers) for forming toner images of respective colors CMYK. The photosensitive drums **402** to **405** are arranged in the order of yellow, magenta, cyan, and black with respect to the intermediate transfer belt **401**, and primarily transfer toner images to the intermediate transfer belt successively.

[0029] Reference numerals **406** to **410** denote units accompanying each of the photosensitive drums **402** to **405**. FIG. **4** shows only the units accompanying the cyan photosensitive drum **404** for convenience of explanation. However, similar units accompany the other photosensitive drums. A primary transfer unit **406** applies a positive (positive-polarity) transfer bias Vt, thereby transferring the toner image formed on the photosensitive drum **404** to the intermediate transfer belt **401**. A cleaner **407** removes toner which is not transferred to the intermediate transfer belt **401** by the primary transfer unit **406**, and which remains on the photosensitive drum **404**. A charging roller **408** uniformly charges the photosensitive drum **404** to the dark part potential VD. An exposing unit **409** emits image exposure light according to the density of image data transferred from the controller unit **101** to the photosensitive drum **404** to change a potential to the bright part potential VL, and forms an electrostatic latent image by using a contrast between the dark part potential VD and the bright part potential VL. A developing unit **410** applies the developing bias Vdc, and forms a toner image on a portion having the bright part potential VL of the surface of the photosensitive drum by using a development contrast which is a development potential difference between the developing bias Vdc and the bright part potential VL. A pre-exposure unit **412** performs "pre-exposure" to uniformly expose the photosensitive drum **404** before charging by the charging roller **408**.

[0030] A toner image **411** is a toner image transferred to the intermediate transfer belt **401** and is a toner image transferred from the preceding yellow and magenta photosensitive drums.

[0031] Next, with reference to FIGS. **4** and **5**A to **5**C, explanation will be made on a mechanism in which "the transfer memory" appears as shown in FIG. **3**. FIGS. **5**A to **5**C are graphs showing the potential of the photosensitive drum **404**. FIG. **5**A shows the potential after the primary transfer unit transfers the toner image, FIG. **5**B shows the potential after the charging roller **408** charges the photosensitive drum **404** to the dark part potential VD, and FIG. **5**C shows the potential after the exposing unit **409** forms the electrostatic latent image.

[0032] In a case where the toner image **411** is already transferred to the intermediate transfer belt **401** at the time of transferring the toner image **411** to the intermediate transfer belt **401** by the primary transfer unit **406**, toner functions as a resistor, and accordingly, a transfer current does not pass through easily from the primary transfer unit **406** to the photosensitive drum **404**. This phenomenon occurs remarkably in a case where the toner amount of the toner image **411** on the intermediate transfer belt is large. For example, this phenomenon occurs remarkably in a case where as the high-density image portion, a red toner image having a density of 100% is formed of a yellow toner image having an amount of 100% and a magenta toner image having an amount of 100%. In this case, the absolute value of the potential of the high-density image portion on the photosensitive drum **404** is higher than the absolute value of the potential of the other image portion as shown in a potential **501** in FIG. **5**A. Further, this potential difference becomes larger as the image density of the high-density image portion becomes higher, that is, as the amount of toner of the toner image formed on the intermediate transfer belt **401** becomes larger.

[0033] A potential state at the time of transferring the toner image by the primary transfer unit **406** is a state in which in a case where a portion having a large potential difference exists as shown by the potential **501**, the potential difference cannot be removed completely even after the charging roller **408** uniformly charges the photosensitive drum **404** to the dark part potential VD. Accordingly, even after charging by the charging roller **408**, the absolute value of the potential becomes higher than the dark part potential VD as shown by a potential **502** of FIG. **5**B.

[0034] In a case where the exposing unit **409** forms the electrostatic latent image in this state, as shown by a potential **503** in FIG. **5**C, a potential difference remains even with respect to the bright part potential VL, and the absolute value of the potential becomes higher than the bright part potential VL. Accordingly, at the time of forming the toner image by the developing unit **410**, the development potential difference between the potential **503** and the development biasing potential Vdc becomes smaller than a potential difference between the developing bias Vdc and the bright part potential VL, which is an original potential difference. Therefore, the toner amount of the formed toner image is small, and the density of the toner image is low. This density difference is a phenomenon called "the transfer memory."

[0035] In this manner, "the transfer memory" appears in an image which is transferred after the photosensitive drum rotates one round with respect to the high-density image portion. In the present embodiment, the length of the circumference of the photosensitive drum **404** is 94 mm, and accordingly, in a case where the high-density image portion exists 94 mm or more ahead of the rear end of an output sheet relative to the conveying direction of the output sheet, "the transfer memory" appears in the same image. On the other hand, in a case where the high-density image portion exists in the rear end relative to the conveying direction of the output sheet, "the transfer memory" appears in a front end portion of a next output sheet.

[0036] Further, "the transfer memory" appears in a case where a low-density toner image is formed in a portion in which a potential difference is generated on the photosensitive drum. In a case where a high-density toner image is formed, the phenomenon is not likely to be conspicuous, and in a case where a toner image is not formed in a blank sheet, the phenomenon does not occur.

[0037] In the printing unit of the present embodiment, in a case where as the high-density image portion, a tone image having an amount (density) of more than 140% is formed on the intermediate transfer belt **401**, "the transfer memory" may appear. Incidentally, in this embodiment, the maximum amount of toner adhered from one photosensitive drum is 100%. Accordingly, in the printing unit of the present embodiment, "the transfer memory" may appear in the following cases, for example. More specifically, in a case where a toner image is formed by the yellow photosensitive drum **402** and the magenta photosensitive drum **403**, and transferred to the intermediate transfer belt **401**, and the total toner amount of the toner image exceeds 140%, "the transfer memory" may appear in the cyan photosensitive drum **404**. In another case where a toner image is formed by the yellow, magenta, and cyan photosensitive drums **402** to **404**, and the total toner amount of the toner image exceeds 140%, "the transfer memory" may appear in the black photosensitive drum **405**.

[0038] In the printing portion of the present embodiment, the pre-exposure unit **412** performs "pre-exposure" processing to reduce "the transfer memory." The "pre-exposure" processing is to emit uniform exposure light to the photosensitive drum **404** whose remaining toner is removed by the cleaner **407** before being charged to the dark part potential VD by the charging roller **408**, and make the potential of the photosensitive drum uniform.

[0039] However, depending on the characteristics of the photosensitive drum, performing the "pre-exposure" processing for all printing processing may adversely affect the durability of the photosensitive drum. Accordingly, it is required to determine whether or not image data to be printed includes the high-density image portion which may cause "the transfer memory," and perform the "pre-exposure" processing only in a case where the high-density image portion exists. In the present embodiment, an existing configuration is used to determine whether or not the high-density image portion exists.

[0040] Next, with reference to FIG. **6**, explanation will be made on the operation of an MFP **100** of the present embodiment. FIG. **6** is a flowchart showing a flow of printing processing in the MFP **100**. Incidentally, in the present embodiment, an application (a program) stored in the storage unit **105** is started in response to a user's operation and instruction, and executed by the controlling unit **104** to realize the following steps.

[0041] In a case where the user instructs the MFP to perform printing, and a print job is input to the MFP **100**, the controlling unit **104** obtains image data to be printed and starts printing processing in step S**601**. In the printing processing, the controlling unit **104** uses the image processing unit **107**, and determines whether or not the high-density image portion exists. Explanation will made below on processing for determining whether the high-density image portion exists in the printing processing performed by the controlling unit **104**.

[0042] In step S**602**, the controlling unit **104** calculates a toner amount conversion coefficient to be set to the toner amount converting unit **207**. The toner amount conversion coefficient is, for example, of a lookup-table (hereinafter referred to as LUT) type, and is used to convert the signal value of each pixel of image data. More specifically, the toner amount conversion coefficient can also be said to be a toner amount conversion table. The following method is performed to calculate the toner amount conversion coefficient for making it possible to determine whether the high-density image portion exists.

[0043] The toner amount conversion coefficient is designed to correspond to the characteristics of the printing unit **103**. This original toner amount conversion coefficient designed to correspond to the characteristics of the printing unit will be referred to as the original toner amount conversion coefficient. The original toner amount conversion coefficient LUT is f(x), where x is the signal value of each pixel of image data. Further, the signal value of image data which should be determined to be the high-density image portion is 1. In the present embodiment, two signal values 1 which are 245 and 255 are signal values based on which image data should be determined to be the high-density image portion. Further, a constant k is set for each of color components CMYK. The constant k is as small a number as possible selected from among prime numbers relatively prime to the maximum density. Namely, the constant k is as small a number as possible selected from among prime numbers other than 3, 5, and 17, which are relatively prime factors of 255 for the maximum density. In the present embodiment, the constant k for the color component cyan is 7, the constant k for the color component magenta is 7, the constant k for the color component yellow is 11, and the constant k for the color component black is 7.

[0044] Using the above values, the controlling unit **104** converts the original toner amount conversion coefficient LUT f(x). The controlling unit **104** converts the original toner amount conversion coefficient LUT f(x) according to the following formula (1):

$$y(x) = \begin{cases} \lfloor f(x) \div k + 0.5 \rfloor \times k & (f(x) \neq l) \\ 255 & (f(x) = l) \end{cases} \quad (1)$$

[0045] where y(x) is a toner amount conversion coefficient after conversion.

[0046] An upper portion of the formula (1) indicates multiplying the constant k by the integer part of f(x) divided by the constant k plus 0.5. Accordingly, in the case of using the toner amount conversion coefficient LUT y(x) obtained by performing the above conversion, a pixel having a signal value other than the signal values 1 of the high-density image portion is converted into a signal value which is a multiple of the constant k. Incidentally, the formula (1) can also be applied to a case where a predetermined threshold such as 244 is used and conversion is performed according to whether f(x) is larger than the predetermined threshold or whether f(x) is equal to or smaller than the predetermined threshold.

[0047] FIG. **7** is a graph of the original toner amount conversion coefficient LUT f(x) and the toner amount conversion coefficient y(x) after conversion for magenta according to the present embodiment. Incidentally, the signal value 1 of the high-density image portion is converted into 255, but the constant k is selected from among prime numbers other than 3, 5, and 17, and 255 is not a multiple of k. Accordingly, in a step described later, the controlling unit **104** refers to a video count value which is the sum of the signal values of pixels after application of LUT as calculated by the video counting unit **208** for image data to which the toner amount conversion coefficient LUT y(x) is applied. More specifically, it becomes possible to determine whether or not the high-density image portion exists based on whether or not the video count value is a multiple of the constant k. In a case where the high-density image portion exists, there exist one or more pixels whose signal values are converted into 255 by LUT y(x), and accordingly, the video count value which is the sum of the signal values of the pixels is not a multiple of the constant k. On the other hand, in a case where the high-density image portion does not exist, all the signal values are converted into multiples of the constant k by LUT y(x), and the video count value which is the sum of the signal values of the pixels is also a multiple of the constant k. Accordingly, the controlling unit **104** can determine whether or not the high-density image portion exists based on whether or not the video count value is a multiple of the constant k.

[0048] More specifically, in the present embodiment, the video count value is finely adjusted to a value such that it is possible to determine whether or not the high-density image portion exists. Meanwhile, this video count value itself is used as the video count value as it is for toner supply control. The video count value calculated by the video counting unit **208** is, as described above, based on the calculated toner amount conversion coefficient LUT y(x), and is not equal to the original toner amount conversion coefficient f(x). Accordingly, an error is caused by converting the toner amount conversion coefficient LUT for a portion other than the high-density image portion into a multiple of the constant k, but the video count value can be obtained as in the case of using f(x) as the toner amount conversion coefficient LUT as it is. Further, the video count value calculated by the video counting unit **208** is used for the toner supply control in the printing unit **103**, and the error caused by conversion into the toner amount conversion coefficient LUT y(x) is at a level which does not affect the toner supply control. Accordingly, in the present embodiment, whether or not the high-density image portion exists can be determined by using existing data used for the toner supply control.

[0049] In this manner, the controlling unit **104** determines whether or not the high-density image portion exists based on whether or not the video count value is a multiple of the constant k. Accordingly, in a case where the number of pixels in the high-density image portion in the image data is a multiple of the constant k, the video count value is also a multiple of the constant k, and the controlling unit **104** determines that the high-density image portion does not exist. In order to reduce the probability that this problem will arise, the present embodiment uses different values as the constants k for magenta and yellow. A condition in which "the transfer memory" is likely to occur is, as described above, that the magenta and/or yellow high-density image portions exist and a toner image having a high amount of toner is formed on the intermediate transfer belt **401**. In the present embodiment, the printing unit **103** performs the "pre-exposure" processing in a case where the magenta and/or yellow high-density image portions exist. Different values are used as the constants k for magenta and yellow, whereby either of the yellow and magenta high-density image portions is detected, and the probability of erroneous determination is reduced.

[0050] Next, returning to FIG. **6**, subsequent processing will be described. In step S**603**, the controlling unit **104** sets the toner amount conversion coefficient calculated in step S**602** to the toner amount converting unit **207**.

[0051] In step S**604**, the controlling unit **104** inputs image data read from the storage unit **105** to the image processing unit **107**, and the image processing unit **107** performs image processing. In the image processing, the image data read from the storage unit **105** is subjected to the image processing by the image processing units **202** to **204**, and input to the toner amount converting unit **207**. The toner amount converting unit **207** converts the signal value of each pixel of the image data according to the toner amount conversion coefficient set in step S**603**. The image data converted by the toner amount converting unit **207** is input to the video counting unit **208**. The video counting unit **208** calculates the sum of all the signal values of the pixels in the image data as the video count value of the image. The video counting unit **208** calculates the video count value for each of the color components CMYK.

[0052] In step S**605**, the controlling unit **104** obtains the video count value for each of the color components CMYK from the video counting unit **208** after performing the image processing on one-page image data in step S**604**.

[0053] In step S**606**, the controlling unit **104** determines whether or not the high-density image portion exists in the image data based on whether or not the video count value for each of the color components CMYK obtained in step S**605** as described above is a multiple of the constant k. The determination is made for each of the color components CMYK. In a case where in step S**606**, the video count value obtained in step S**605** is a multiple of the constant k, the controlling unit **104** determines in step S**607** that the high-density image portion does not exist in the image data. On the other hand, in a case where in step S**606**, the video count value obtained in step S**605** is not a multiple of the constant k, the controlling unit **104** determines in step S**608** that the high-density image portion exists in the image data.

[0054] In step S**609**, the controlling unit **104** notifies the printing unit **103** of information indicating the result of the determination of whether the high-density image portion exists for each of the color components CMYK as determined in steps S**607** and S**608**. The printing unit **103** performs control regarding whether or not to perform the "pre-exposure" processing in forming an image by using the result of the determination of whether or not the high-density image portion exists as given by the controlling unit **104**. For example, in a case where it is determined that the high-density image portion exists for at least one of the cyan and magenta color components as described above, control is performed to perform the "pre-exposure" processing. Naturally, the present embodiment is not limited to this combination, and in the present embodiment, in a case where it is determined that the high-density image portion exists for at least one of the color components, control can be performed to perform the "pre-exposure" processing. In a case where it is determined that the high-density image portion exists, the "pre-exposure" processing is performed on the photosensitive drums for all the colors, for example. Otherwise, the "pre-exposure" processing may be performed only on a downstream photosensitive drum in which the "transfer memory" may appear.

[0055] In step S**610**, the controlling unit **104** reads image data which is subjected to image processing by the image processing unit **107** and temporarily stored in the storage unit **105**, inputs the image data to the print image outputting unit **108**, and performs print image processing. The image data which is subjected to the print image processing by the print image outputting unit **108** is transferred to the printing unit **103**, and the printing unit **103** performs image forming processing to print an output sheet.

[0056] In step S**611**, the controlling unit **104** notifies the printing unit **103** of the video count value for each of the color components CMYK obtained in step S**605**. The printing unit **103** estimates the consumption amount of toner used for the image forming processing by using the video count value given by the controlling unit **104** and performs the toner supply control at the printing unit **103**.

[0057] The above is the explanation on processing for detecting the high-density image portion in the image data in order to cope with "the transfer memory" in the MFP **100**. By using the video counting processing, this processing makes it possible to determine whether the high-density image portion exists in the image data and to obtain the video count value used for toner supply control. In this manner, the present embodiment uses processing for calculating the video count, thereby making it possible to calculate the video count value and to detect the high-density image without reducing the processing speed of printing processing.

Embodiment 2

[0058] Next, with reference to FIGS. **6** and **8**, explanation will be made on the operation of the MFP **100** of Embodiment 2. FIG. **6** is the flowchart showing the flow of the printing processing of the MFP **100**, and is the same as the flowchart for Embodiment 1. Further, in the present embodiment, the hardware configuration and software configuration of the MFP **100** and the schematic of image forming are the same as those explained in Embodiment 1.

[0059] A difference between Embodiment 1 and Embodiment 2 lies only in processing for calculating the toner amount conversion coefficient in step S**602**. Accordingly, in Embodiment 2, only this difference will be described.

[0060] In step S**602**, the controlling unit **104** calculates the toner amount conversion coefficient to be set to the toner amount converting unit **207**. In Embodiment 2, the toner amount conversion coefficient for enabling determination of the high-density image portion is calculated by the following method.

[0061] In Embodiment 2, the original toner amount conversion coefficient LUT is f(x) as in Embodiment 1. Here, x is the signal value of each pixel in the image data. Further, a threshold for the density of the image data to be determined as the high-density image portion is m %. A pixel corresponding to a density wherein the signal value of the image data exceeds m % constitutes the high-density image portion. Further, the constant k is set for each of the color components CMYK. The constant k is as small a number as possible selected from among prime numbers other than 3, 5, and 17 as in Embodiment 1. In the present embodiment, the constant k is set at 7 for each of the color components CMYK unlike in Embodiment 1.

[0062] Using the above values, the controlling unit **104** converts the original toner amount conversion coefficient LUT f(x). The controlling unit **104** converts the original toner amount conversion coefficient LUT f(x) according to the following formula (2):

$$y(x) = \begin{Bmatrix} \lfloor f(x) \div k + 0.5 \rfloor \times k & (f(x) \leq (255 \times m \div 100)) \\ \lfloor f(x) \div k + 0.5 \rfloor \times k + 3 & (f(x) > (255 \times m \div 100)) \end{Bmatrix} \quad (2)$$

where y(x) is the toner amount conversion coefficient after conversion.

[0063] A pixel having a signal value corresponding to a density of m % or less is converted into a signal value which is a multiple of the constant k by the toner amount conversion coefficient LUT y(x) obtained by performing the conversion. The signal value of the high-density image portion having the signal value corresponding to a density of more than m % is converted into a signal value which is a multiple of the constant k+3.

[0064] FIG. **8** is a graph of the magenta original toner amount conversion coefficient LUT f(x) and the toner amount conversion coefficient LUT y(x) after conversion according to the embodiment of the present invention.

[0065] Since the constant k is 7 in the present embodiment, a multiple of the constant k+3 is not a multiple of the constant k. Accordingly, the controlling unit **104** refers to the video count value which is the sum of the signal values of the pixels after application of LUT as calculated by the video counting unit **208** for the image data to which the toner amount conversion coefficient LUT y(x) is applied. It becomes possible to determine whether or not the high-density image portion having the density of more than m % exists based on whether or not the video count value is a multiple of the constant k. In other words, in a case where the high-density image portion exists, there exist one or more pixels whose signal values are converted into multiples of the constant k+3 by LUT y(x), and accordingly, the video count value which is the sum of the signal values of the pixels is not a multiple of the constant k. On the other hand, in a case where the high-density image portion does not exist, all the signal values are converted into multiples of the constant k by LUT y(x), and the video count value which is the sum of the signal values of the pixels is also a multiple of the constant k. Accordingly, the controlling unit **104** can determine whether or not the high-density image portion exists based on whether or not the video count value is a multiple of the constant k. Meanwhile, an error is caused in the video count value calculated by the video counting unit **208** by converting the toner amount conversion coefficient LUT for a portion other than the high-density image portion into a multiple of the constant k and converting the toner amount conversion coefficient LUT for the high-density image portion into a multiple of the constant k+3. However, the video count value can be obtained as in the case of using f(x) as the toner amount conversion coefficient LUT as it is. Further, the video count value calculated by the video counting unit **208** is used for the toner supply control in the printing unit **103**, and the error caused by conversion into the toner amount conversion coefficient LUT y(x) is at a level which does not affect the toner supply control.

[0066] The controlling unit **104** determines the high-density image portion based on whether or not the video count value is a multiple of the constant k. Accordingly, in a case where the number of pixels of the high-density image portion in the image data is a multiple of the constant k, the video count value is also a multiple of the constant k, and the controlling unit **104** determines that the high-density image portion does not exist.

[0067] In Embodiment 1, explanation has been made on the example in which the printing unit **103** performs the "pre-exposure" processing in a case where the printing unit **103** is informed of the determination that the high-density image portion exists for one of the color components CMY among the results of the determinations of whether or not the high-density image portion exists for the color components CMYK as given by the controlling unit **104** in step S**609**. The printing unit **103** of the present embodiment performs the "pre-exposure" processing in a case where the printing unit **103** is informed of the determination that the high-density image portion exists for two of the color components CMY among the results of the determinations of whether or not the high-density image portion exists for the color components CMYK as given by the controlling unit **104** in step S**609**. In other words, the printing unit **103** performs the "pre-exposure" processing in a case where the high-density image portion exists for a combination of two color components C and M, C and Y, or M and Y or a combination of three color components C, M, and Y. As in Embodiment 1, the "pre-exposure" processing may be performed on the photosensitive drums for all the colors, or only on a downstream photosensitive drum affected by the "transfer memory." In this manner, in the present embodiment, the printing unit **103** performs the "pre-exposure" processing in a case where the printing unit is informed of the determination that the high-density image portion exists for two of the color components CMY. Accordingly, unlike in Embodiment 1, the same value is used for the constant k for each of the color components CMYK, thereby reducing the probability that it is erroneously determined whether or not the high-density image portion exists.

[0068] The above is the explanation on processing for detecting the high-density image portion in the image data in order to cope with "the transfer memory" in the MFP **100**. By using the video counting processing, this processing makes it possible to determine whether or not the high-density image portion having the density of more than m % exists in the image data and to obtain the video count value used for toner supply control.

Embodiment 3

[0069] Next, with reference to FIGS. **9** and **10**, explanation will be made on the operation of the MFP **100** of Embodiment 3. FIG. **9** is a flowchart showing a flow of printing processing in the MFP **100**. Steps S**901**, S**903**, S**904**, S**909**, and S**910** in FIG. **9**, which is the flowchart, are the same as steps S**601**, S**603**, S**604**, S**609**, and S**610** in the flowchart for Embodiment 1. Further, in the present embodiment, the hardware configuration and software configuration of the MFP **100** and the schematic of image forming are the same as those explained in Embodiment 1.

[0070] Accordingly, explanation will be made on only differences between the flowchart (FIG. **9**) for the present embodiment and the flowchart for Embodiment 1.

[0071] In step S**902**, the controlling unit **104** calculates the toner amount conversion coefficient to be set to the toner amount converting unit **207**. Also in the present embodiment, the original toner amount conversion coefficient LUT corresponding to the characteristics of the printing unit **103** is f(x) where x is the signal value of each pixel of the image data. Further, the signal value of the image data which should be determined to be the high-density image portion is 1. In the present embodiment, the two signal values 1 which are 245 and 255 are the signal values based on which the image data should be determined to be the high-density image portion.

[0072] In the present embodiment, the video count value is converted into a determination value indicating whether or not the high-density image portion exists by using the toner amount conversion coefficient. In Embodiments 1 and 2, explanation has been made on the examples in which the value converted by using the toner amount conversion coefficient is used as the video count value for the toner supply control in the video counting unit **208**. In the present embodiment, a value (a determination value) converted by using the toner amount conversion coefficient is not used as the video count value for toner supply control in the video counting unit **208**. The controlling unit **104** converts the original toner amount conversion coefficient LUT f(x) according to the following formula (3).

$$y(x) = \begin{Bmatrix} 0 & (f(x) \neq l) \\ 255 & (f(x) = l) \end{Bmatrix} \quad (3)$$

where y(x) is the toner amount conversion coefficient after conversion.

[0073] The signal value of a pixel having a signal value other than the signal value 1 of the high-density image portion is converted into 0 by the toner amount conversion coefficient LUT y(x) obtained by performing the conversion, and the signal value 1 of the high-density image portion is converted into 255.

[0074] The controlling unit **104** can determine whether or not the high-density image portion exists based on whether or not the determination value which is the sum of the signal values of the pixels after application of LUT is 0 for the image data to which the toner amount conversion coefficient LUT y(x) is applied. In a case where the high-density image portion exists, there exist one or more pixels whose signal values are converted into 255 by LUT y(x), and accordingly, the determination value which is the sum of the signal values of the pixels is not 0. In a case where the high-density image portion does not exist, all the signal values are converted into 0 by LUT y(x), and accordingly, the determination value which is the sum of the signal values of the pixels is 0. FIG. **10** is a graph of examples of the magenta original toner amount conversion coefficient LUT f(x) and the toner amount conversion coefficient y(x) after conversion according to the present embodiment.

[0075] In step S**905**, the controlling unit **104** obtains the determination value calculated by the video counting unit **208** in step S**904**. In step S**906**, the controlling unit **104** determines whether or not the high-density image portion exists in the image data based on whether or not the determination value obtained in step S**905** is 0 as stated above. The determination is made for each of the color components CMYK. In a case where it is determined in step S**906** that the determination value obtained in step S**905** is 0, the controlling unit **104** determines in step S**907** that the high-density image portion does not exist in the image data. On the other hand, in a case where it is determined in step S**906** that the determination value obtained in step S**905** is not 0, the controlling unit **104** determines in step S**908** that the high-density image portion exists in the image data.

[0076] In step S**909**, the controlling unit **104** notifies the printing unit **103** of the results of the determinations of whether or not the high-density image portion exists for each of the color components CMYK as determined in steps S**907** and S**908**. The printing unit **103** performs control regarding whether or not to perform the "pre-exposure" processing in forming an image by using the results of the determinations of whether or not the high-density image portion exists as given by the controlling unit **104**.

[0077] Incidentally, in the present embodiment, the printing unit **103** uses the video count value, not the determination value calculated by the video counting unit **208** for the toner supply control.

[0078] The above is the explanation on processing for detecting the high-density image portion in the image data in order to cope with "the transfer memory" in the MFP **100**. By using the video counting processing, this processing makes it possible to determine whether or not the high-density image portion exists in the image data.

OTHER EMBODIMENTS

[0079] In the above embodiments, explanation has been made on the examples in which the printing unit **103** is informed of the results of the determinations of whether or not the high-density image portion exists. However, it is possible to use a configuration in which in a case where the printing unit **103** is set to perform "pre-exposure" by default, for example, only if the high-density image portion does not exist, the printing unit **103** is informed of this. On the other hand, it is possible to use a configuration in which in a case where setting is not made to perform "pre-exposure" by default, only if the high-density image portion exists, the printing unit **103** is informed of this.

[0080] According to the present invention, it becomes possible to obtain the video count value used for the toner supply control and determine whether or not the high-density image portion exists in the image data by using the video counting processing for toner supply mounted with an existing hardware configuration.

[0081] Embodiment(s) of the present invention can also be realized by a computer of a system or apparatus that reads out and executes computer executable instructions (e.g., one or more programs) recorded on a storage medium (which may also be referred to more fully as a 'non-transitory computer-readable storage medium') to perform the functions of one or more of the above-described embodiment(s) and/or that includes one or more circuits (e.g., application specific integrated circuit (ASIC)) for performing the functions of one or more of the above-described embodiment(s), and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the computer executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s) and/or controlling the one or more circuits to perform the functions of one or more of the above-described embodiment(s). The computer may comprise one or more processors (e.g., central processing unit (CPU), micro processing unit (MPU)) and may include a network of separate computers or separate processors to read out and execute the computer executable instructions. The computer executable instructions may be provided to the computer, for example, from a network or the storage medium. The storage medium may include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD)™), a flash memory device, a memory card, and the like.

[0082] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

[0083] This application claims the benefit of Japanese Patent Application No. 2014-252060, filed Dec. 12, 2014, which is hereby incorporated by reference wherein in its entirety.

What is claimed is:

1. An image forming apparatus having a counting unit configured to count an amount of toner used for an image to be printed for each color component, the image forming apparatus comprising:

a setting unit configured to set a conversion coefficient used for processing for converting a pixel value in image data expressing the image into a signal value indicating the amount of toner;

a converting unit configured to convert the pixel value into the signal value by using the set conversion coefficient; and

an outputting unit configured to output information indicating whether or not a high-density image portion is included in the image based on the signal value obtained by performing the conversion.

2. The image forming apparatus according to claim **1**, wherein

the counting unit counts a sum of signal values obtained by performing the conversion by the converting unit, and

the outputting unit outputs the information based on the sum of the signal values counted by the counting unit.

3. The image forming apparatus according to claim **1**, wherein the setting unit sets a conversion table used for the converting unit as the conversion coefficient.

4. The image forming apparatus according to claim **3**, wherein the setting unit sets the conversion table for performing the conversion such that a signal value after the conversion is not a multiple of a constant k in a case where the pixel value is larger than a predetermined threshold, and the signal value after the conversion is a multiple of the constant k in a case where the pixel value is equal to or smaller than the predetermined threshold.

5. The image forming apparatus according to claim **4**, wherein the constant k is a prime number relatively prime to a maximum value of the signal value of a pixel.

6. The image forming apparatus according to claim **5**, wherein the constant k for at least a certain color component is different from the constant k for another color component.

7. The image forming apparatus according to claim **6**, wherein the outputting unit outputs information indicating that the high-density image portion is included in the image in a case where there is at least one color component in which the sum of the signal values counted by the counting unit is a multiple of the constant k.

8. The image forming apparatus according to claim **5**, wherein the constant k is the same for all the color components.

9. The image forming apparatus according to claim **8**, wherein the outputting unit outputs information indicating that the high-density image portion is included in the image in a case where there are at least two color components in which the sum of the signal values counted by the counting unit is a multiple of the constant k.

10. An image forming apparatus having a counting unit configured to count a total amount of toner used for an image to be printed for each color component, the image forming apparatus comprising:

a setting unit configured to set a conversion coefficient used for processing for converting a pixel value in image data expressing the image into a signal value indicating the amount of toner;

a converting unit configured to convert the pixel value into the signal value and a determination value indicating whether or not a high-density image portion is included based on the set conversion coefficient; and

an outputting unit configured to output information indicating whether or not the high-density image portion is included in the image based on the determination value obtained by performing the conversion.

11. The image forming apparatus according to claim **1**, further comprising a controlling unit configured to control an exposing unit configured to perform pre-exposure to expose an image carrier before charging by a charging unit, wherein

the controlling unit controls whether or not to perform the pre-exposure based on information output by the outputting unit.

12. The image forming apparatus according to claim **11**, wherein the controlling unit controls the pre-exposure on the image carrier for each color component in a case where the information output by the outputting unit is the information indicating that the high-density image portion is included in the image.

13. A non-transitory computer readable storage medium storing a program which causes a computer to perform a method for controlling an image forming apparatus having a counting unit configured to count an amount of toner used for an image to be printed for each color component, the method comprising:

setting a conversion coefficient used for processing for converting a pixel value in image data expressing the image into a signal value indicating the amount of toner;

converting the pixel value into the signal value by using the set conversion coefficient; and

outputting information indicating whether or not a high-density image portion is included in the image based on the signal value obtained by performing the conversion.

* * * * *