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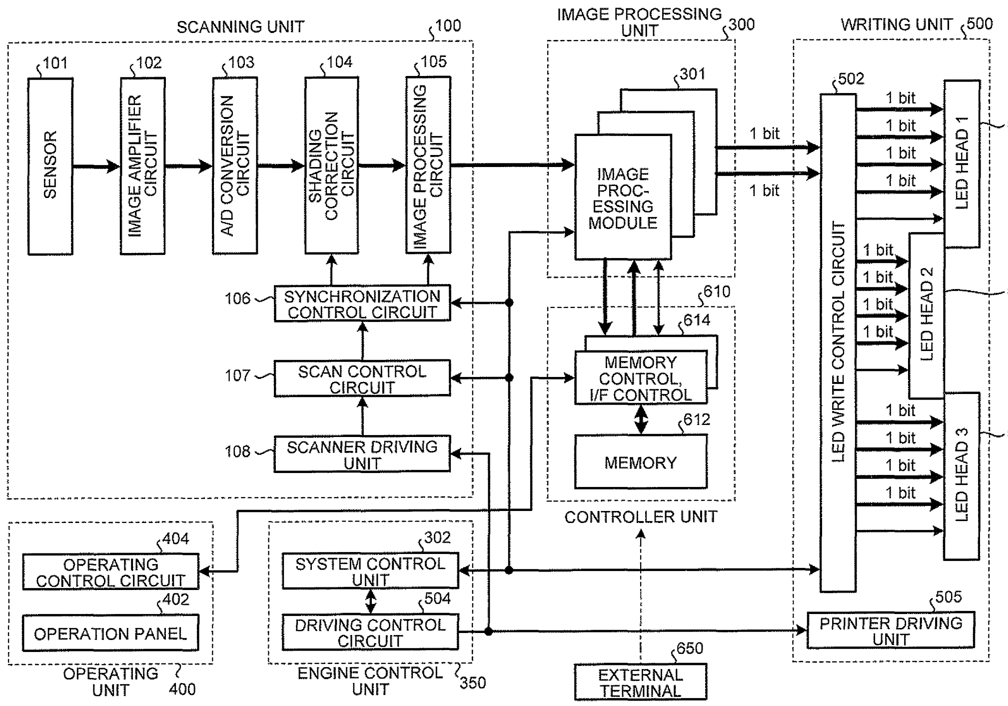
(54) Writing device, image forming apparatus, and writing method

(57) In an embodiment, a writing device receives a binary signal in accordance with image data, and writes an image based on the signal. The writing device includes a multiple-value unit (300) and a writing unit (500). The multiple-value unit (300) outputs a multiple-value signal based on the received binary signal. The number of the multiple values is an integral multiple of the binary. The writing unit (500) writes a binary image having a lager resolution than the image data based on the multiple-value signal.

FIG.1



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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to and incorporates by reference the entire contents of Japanese Patent Application No. 2011-202400 filed in Japan on September 15, 2011 and Japanese Patent Application No. 2012-191982 filed in Japan on August 31, 2012.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a writing device, an image forming apparatus, and a writing method.

2. Description of the Related Art

[0003] A writing device that writes a latent image by irradiating a photosensitive element with light employs an LD scanning structure using a laser beam or a light-emitting-element array structure in which an LED light-emitting element is arranged in an array manner. The writing device with the light-emitting-element array structure has high reliability because the writing device includes no movable portion such as a polygon mirror in the LD scanning structure. Further, the writing device with the light-emitting-element array structure requires no optical space which is scanned with a light beam in a main-scanning direction even in an image forming apparatus that prints a wide-size format such as an A0-size format. Also, the writing device with the light-emitting-element array structure may arrange an LED head in which an LED light-emitting-element array and an optical element such as a SELFOC (trademark) lens array are integrated. As a result, the entire apparatus can be downsized.

[0004] A writing device with the light-emitting-element array structure requires a light-emitting-element array having a longer width than an image writing width. If the length of the light-emitting-element array is lengthened, an LED element driver IC for use is increased, so that a production yield is lowered. Further, in order to maintain writing beam array precision, it is necessary to improve parts precision. Furthermore, such a lengthened light-emitting-element array unit as a whole needs to be replaced in a case where even a single dot is damaged in the light-emitting-element array unit. To solve this problem, has been proposed a plurality of light-emitting-element array units arranged side by side in the main-scanning direction.

[0005] Also, to control a light-emitting amount of the light-emitting element positioned at an overlapped portion of the plurality of light-emitting-element array units, used is a multiple-value light-emitting-element array unit. In each of the multiple-value light-emitting-element array a unit, light emission of one dot corresponds to multiple values of five bits (32 values), for example; and a light beam can be varied in 32 levels. The multiple-value light-emitting-element array unit can be controlled and adjusted so as to suppress occurrence of an uneven amount of light of a white streak and a black streak at an overlapped position of the plurality of light-emitting-element array unit (uneven pitch of the light-emitting element occurring due to assembly precision of the overlapped position). However, in a case with a binary-controlled light-emitting element, it is difficult to change the light beam.

[0006] In view of the above-problem, in Japanese Patent Application Laid-open No. 2004-122718, disclosed is a technique where image data at an overlapped portion of the light-emitting-element array unit and other image data are divided and transferred within one line, and a duty ratio is controlled so that a white streak or a black streak at the overlapped portion is suppressed and becomes less remarkable. However, an image of the overlapped portion varies, and there is a possibility that the image may become patchy or bold in a certain lighting time, and therefore it has been unable to improve an uneven amount of light at a gap between image dots. More specifically, when an isolated point of one dot exists at the overlapped portion and if the duty ratio of overlapping is small, the lighting time becomes short and is less than the lighting time of a normal image. Therefore, a dot diameter cannot be satisfied. Meanwhile, in a halftone portion, there is a possibility that the dot diameter may not become the same as surrounding dot diameters.

[0007] In view of the foregoing, the present invention has been made and an object is to easily obtain a good-quality output image.

SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to at least partially solve the problems in the conventional technology.

[0009] In an embodiment, a writing device receives a binary signal in accordance with image data, and writes an image based on the signal. The writing device includes a multiple-value unit and a writing unit. The multiple-value unit outputs a multiple-value signal based on the received binary signal. The number of multiple values is an integral multiple of the binary. The writing unit writes a binary image having a lager resolution than the image data based on the multiple-value signal.

[0010] In another embodiment, an image forming apparatus includes the writing device mentioned above.

[0011] In still another embodiment, a writing method for a writing device includes: outputting a multiple-value signal based on a binary signal in accordance with image data, the multiple value being an integral multiple of the binary; and writing a binary image having a larger resolution than the image data based on the multiple-value signal.

[0012] The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 is a block diagram illustrating a function and a peripheral configuration provided by an image forming apparatus according to an embodiment;
FIG. 2 is a diagram illustrating a configuration of the image forming apparatus according to the present embodiment;
FIG. 3 is a diagram illustrating a configuration and a periphery of an LED write control circuit;
FIG. 4 is a diagram illustrating an example of coding of pixel data;
FIG. 5A is a diagram illustrating an outline of an LED head arrangement;
FIG. 5B is an enlarged view of an overlapped portion of the LED heads of FIG. 5A;
FIG. 5C is a diagram of resolution converted from 600 dpi to 1200 dpi;
FIG. 6A is a diagram illustrating an example of the pixel data and lighting time (10% duty);
FIG. 6B is a diagram illustrating an example of the pixel data and lighting time (2.5% per pixel);
FIG. 6C is a diagram illustrating an example of the pixel data and patterns; and
FIG. 6D is a diagram illustrating a controlling example of the pixel data and lighting time.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] An embodiment of an image forming apparatus will be herein described in detail with reference to the appended drawings. FIG. 1 is a block diagram illustrating a function and a peripheral configuration provided by an image forming apparatus according to an embodiment. The image forming apparatus equipped with functions illustrated in FIG. 1 is, for example, a facsimile machine, a printing apparatus (printer), a copying machine, or an MFP.

[0015] As illustrated in FIG. 1, the image forming apparatus includes a scanning unit 100, an image processing unit 300, an engine control unit 350, an operating unit 400, a writing unit 500, and a controller unit 610; and an external terminal 650 is configured to be connected to the image forming apparatus. The scanning unit 100 is a scanning unit that scans a document. The image processing unit 300 includes a plurality of image processing modules 301, each of which having a different function, and generates image data for writing used by the writing unit 500 based on the document scanned by the scanning unit 100 and image data received via the controller unit 610.

[0016] The engine control unit 350 includes: a system control unit 302 that controls execution of a series of processes performed by each unit that constitutes the image forming apparatus; and a driving control circuit 504 that controls each driving unit in the image forming apparatus. The operating unit 400 includes an operation panel 402 as an operating unit with which a key operation is performed, and an operating control circuit 404 that controls a connection between the operation panel 402 and the controller unit 610. The controller unit 610 includes a memory 612 that temporarily accumulates an image, and a control modules 614, each of which having a different function. The control module 614 performs, for example, an interface (I/F) control, a memory control, and the like. Note that the external terminal 650 is, for example, a PC (personal computer) or the like, and, for example, outputs image data with the resolution (pixel density) of 600 dpi to the image forming apparatus, so that the image forming apparatus forms an image with the resolution of 1200 dpi described below, for example.

[0017] Next, a configuration and an operation of the scanning unit 100 will be described with reference to FIGS. 1 and 2. FIG. 2 is a diagram illustrating a configuration of the image forming apparatus according to the present embodiment. When an operator inserts a document into an insertion port of the scanning unit 100, the document is conveyed between a contact sensor 2 and a white roller 3 in response to rotation of a roller 1. The document while being conveyed is irradiated with an LED attached to the contact sensor 2; the reflected light thereof is imaged at the contact sensor 2; and document image information is scanned. Referring to FIG. 1, the document image imaged at a sensor 101 is converted into an electric signal; and this analog signal is amplified by an image amplifier circuit 102. An AD conversion circuit 103 converts the analog image signal amplified by the image amplifier circuit 102 into a multiple-value digital image signal for each pixel. The converted digital image signal is output in synchronization with a clock output from a synchronization control circuit 106; and a shading correction circuit 104 corrects distortion caused by an uneven amount of light, a stain on an exposure glass, uneven sensitivity of the sensor 101, or the like. The corrected digital image information is converted into digital recording image information (image data) by an image processing circuit 105, and is then output to the image processing unit 300.

[0018] Next, described will be configurations of the writing unit 500 and the system control unit 302 that control a series of processes for forming an image on a recording sheet based on the image data input to the image processing unit 300. The system control unit 302 includes, as described above, a function for executing and controlling a series of processes. The system control unit 302 transfers image data in a scan control circuit 107, the synchronization control circuit 106, the image processing unit 300, and an LED write control circuit 502, and drives a motor (not illustrated) and the like via a scanner driving unit 108 and a printer driving unit 505 operated by control of the driving control circuit 504, thereby smoothly controlling the conveyance of the scanned document and the recording sheet The writing unit 500 converts the image data transferred from the image processing unit 300 in synchronization with a transfer reference clock signal in a unit of one pixel by the LED write control circuit 502, and converts the converted data into infrared light by LED heads 503_1 to 503_3, and outputs.

[0019] Next, a process for forming an image on a recording sheet by the image forming apparatus will be described with reference to FIG. 2. A charging device 4 is referred to as a scorotron charger with a grid that uniformly charges a photosensitive drum 5 with -1200 V. A light-emitting-element array unit (LED head) 6 is formed by LEDs that are arranged in an array manner, and irradiates the photosensitive drum 5 through an SLA (SELFOC (trademark) lens array). The light-emitting-element array unit (LED head) 6 corresponds to the LED heads 503_1 to 503_3 of FIG. 1.

[0020] When the photosensitive drum 5 is irradiated with the LED light based on the digital image information, an electric charge on a surface of the photosensitive drum 5 flows into the ground of the photosensitive drum 5 and disappears by photoconductive effect. Here, a portion having low document density is prevented from being irradiated with an LED, whilst a portion having high document density is irradiated with an LED. As a result, an electrostatic latent image corresponding to the image density is formed on the photosensitive drum 5 due to the irradiation by the LED light. The electrostatic latent image is developed by a developing unit 7. A toner of the developing unit 7 is charged negative by stirring; and a bias of -700 V is applied. Therefore, the toner adheres only on the LED light irradiation portion. Meanwhile, the recording sheet is selected from three feeding tables and a bypass, and passes under the photosensitive drum 5 at a predetermined timing with a registration roller 8 while a toner image is transferred on the recording sheet by a transfer charger 9. The recording sheet is then separated from the photosensitive drum 5 by a separating charger 10; is conveyed by a conveying tank 11; and is transferred to a fixing unit 12 where the toner is fixed on the recording sheet. The recording sheet having the fixed toner is carried to the front or back of the machine, and is discharged to a discharge tray 13 or 14.

[0021] When copying is executed, for example, the image data is transferred from the scanning unit 100 to the image processing unit 300, and then to the controller unit 610. The image data is again transferred from the image processing unit 300 to the writing unit 500. Also, while a printer outputting, the image data is output from the external terminal 650; passes through the controller 610; and is transferred to the writing unit 500 via the image processing unit 300. A flow of the image data from the image processing unit 300 to the writing unit 500 will be described next, the flow being a common image data path when copying is executed and when a printer is output. The image data is transferred from the image processing unit 300 to the LED write control circuit 502 in the writing unit 500. More specifically, binary image data having the resolution of 600 dpi stored in the image processing unit 300 is transferred into two pixels in parallel to the LED write control circuit 502 in synchronization with a transfer reference clock signal. The two pixels transferred in parallel are an odd-numbered pixel (odd) and an even-numbered pixel (even) in the main-scanning direction of the binary image data. Next, the image data transferred in two pixels in parallel is synthesized into one line image data in the LED write control circuit 502. The one line image data is image data composed of all pixels in the main-scanning direction and one pixel in the sub-scanning direction in the binary image data. The one line image data is then divided into three data in the LED write control circuit 502, and are transferred into the LED heads 503_1 to 503_3.

[0022] Next, the LED write control circuit 502 will be described with reference to FIG. 3. FIG. 3 is a diagram illustrating a configuration and a periphery of the LED write control circuit 502. First, an image data input unit (LVDS receiver) 512 will be described. The binary image data (even pixel (even), odd pixel (odd)) and a timing signal are converted from parallel signals into a serial signal by a low-voltage differential signal element LVDS driver (not illustrated), and are transferred from the image processing unit 300 to the LED write control circuit 502 with a transfer reference clock frequency. In the LED write control circuit 502, the serial signal is converted into parallel signals by the LVDS receiver 512, and each of the parallel signals including PKDE, PKDO, CLKA, LSYNC_N, LGATE_N, and FGATEIPU_N is input to a function block 510_1 in an IC 510.

[0023] Next, described is an operation of the IC 510 with respect to first image data RAM units (SRAMs) 550_1 to 550_6 in which a plurality of lines of the binary image data input to the writing unit 500 is stored. The function block 510_1 in the IC 510 stores DEOI [1:0] data in a unit of two pixels in the SRAMs 550_1 to 550_6 line by line in synchronization with a reference clock signal CLKA. After storing the image data of the three lines in the SRAMs 550_1 to 550_3, the function block 510_1 reads out, while transferring the image data of the fourth line into the SRAM 550_4, other image data of the SRAMs 550_5, 550_6, and 550_1 to 550_3 in order of address; and transfers the read data to the function block 510_2 in the IC 510. The function block 510_2 targets a pixel data of the first line of the SRAM 550_1 from among the transferred image data; compares the target pixel data with a pixel data in the main-scanning direction and in the sub-scanning direction that surrounds the target pixel data (around the target pixel data); converts the target pixel data from the binary into 16 values (coding); and transfers the converted data to a second image data RAM unit in the next step. Further, as the image data processing of the second line, the function block 510_2 reads out, while transferring the image data of the fifth line to the SRAM 550_5, the image data of the SRAMs

550_6, and 550_1 to 550_4 one by one; compares a target pixel data of the second line with a pixel data in the main-scanning direction and in the sub-scanning direction that surrounds the target pixel data; codes the target pixel data from the binary into 16 values; and transfers the coded data into the second image data RAM unit in the next step. The coding will be described below with reference to FIGS. 5A to 5C. However, in a case of printing in black, for example, the binary data of the pixel in binary is 1b, and becomes 1111b when converted into 16 values.

[0024] As described above, the IC 510 operates the SRAMs 550_1 to 550_6 one by one, and reads out, while transferring the image data of one line, other five image data of the SRAMs that have not been transferred yet in order of address; and codes the image data as a matrix pattern that extends in the main-scanning direction and in the sub-scanning direction with respect to the target line. Here, it is noted that the multiple value of sixteen when coding (multiplying) is presented only as an example, and any multiple value that is multiplied by two can be used.

[0025] Next, an operation of the IC 510 with respect to second image data RAM units (SRAMs) 514A_1 to 514A_3, and 514B_1 to 514B_3 will be described. The function block 510_2 processes the coded (multiplied) pixel data in a unit of four pixels by increasing the clock frequency; and transfers and stores the processed data in the three SRAMs (514A_1 to 514A_3) in A-group and in the three SRAMs (514B_1 to 514B_3) in B-group by SRAM address signals of ADRA [10:0] and ADRB [10:0] as SRAMDI [15:0]. Here, the function block 510_2 stores, among the pixel data of the first line, the pixel data of the LED head 503_1 in the A-group SRAM 514A_1, the pixel data of the LED head 503_2 in the A-group SRAM 514A_2, and the pixel data of the LED head 503_3 in the A-group SRAM 514A_3.

[0026] Next, the function block 510_2 simultaneously reads out the pixel data that have been stored one by one in the A-group three SRAMs (514A_1 to 514A_3), while transferring the next line pixel data to the B-group. When reading out the pixel data that have been stored one by one in the A-group three SRAMs (514A_1 to 514A_3), the function block 510_2 causes the clock frequency at reading to be twice the clock frequency at writing in order to double a writing speed by the LED head in the main-scanning direction. That is to say, the function block 510_2 reads out the image data so as to convert the clock frequency in order for the LED head, capable of printing out on 1200 dpi, to print out the image of which resolution (pixel density). Further, the function block 510_2 reads out the pixel data so as to make the writing frequency in the sub-scanning direction match the LED head capable of 1200 dpi. When the writing frequency by the LED head in the sub-scanning direction is halved, a frequency of LSYNC signal that controls a start timing of writing by the LED head in a unit of one line is changed to be half. In this way, the function block 510_2 converts the density (resolution) from 600 dpi to 1200 dpi in such a way that 16-value (four pixels: 4 bits) pixel data can be written by 1200 dpi on a region of the recording sheet where the binary (one pixel: 1 bit) pixel data is written by 600 dpi. The function block 510_2 reads out lower two bits of each pixel from among the coded (multiplied) pixel data in the first line, and transfers the read data into field memories (FMs) 515_1 to 515_3 in the image data delaying unit.

[0027] That is, as described above, the function block 510_2 reads out the lower two bits of each 16-value data in the first reading; and retrieves upper two bits of the pixel data in the second reading. Then, the function block 510_2 transfers the image data having a double data amount in the main-scanning direction and two lines in the sub-scanning direction to the field memories 515_1 to 515_3. Note that, in the present embodiment, the IC 510 transfers the image data having two lines in the sub-scanning direction to the field memories 515_1 to 515_3 by reading out the image data twice. However, the number of transfer may be changed in accordance with transfer order of image data depending on the image transfer method of the LED heads 503_1 to 503_3. Note that the function block 510_2 writes the image data according to the number of lines set in a register 510_4 as a storing unit in the field memories 515_1 to 515_3. The LED head 503_1 does not require a delaying operation because the LED head 503_1 is used as a reference of writing timing in the sub-scanning direction. Also, the function block 510_2 transfers the image data of the LED head 503_2 to the field memory 515_2 that is cascade-connected to the field memory 515_1, and the image data of the LED head 503_3 to the field memory 515_3. Further, the function block 510_2 stores the image data of the next line in the B-group SRAMs 514B_1 to 514B_3 in a similar manner to A-group while reading out the image data of the first line from the A-group SRAMs 514A_1 to 514A_3. Further, the function block 510_2 carries out overlapping between the lines by alternately carrying out reading and writing of the A-group SRAMs 514A_1 to 514A_3 and the B-group SRAMs 514B_1 to 514B_3.

[0028] Next, image data delaying units 515_1 to 515_3 will be described. The LED heads 503_1 to 503_3 are arranged in a "so-called" staggered manner, that is, the LED heads are arranged to extend in the main-scanning direction and mutual end portions are shifted and overlapped in the sub-scanning direction. For example, the LED head 503_2 is shifted by 17.5 mm in the sub-scanning direction and attached using the LED head 503_1 as a reference. Therefore, when the image data output from the A-group three SRAMs (514A_1 to 514A_3) and the B-group three SRAMs (514B_1 to 514B_3) are simultaneously processed and transferred to the LED head 503_2, the LED head 503_2 is shifted by 17.5 mm in the sub-scanning direction with respect to the LED head 503_1 and printed.

[0029] To correct the mechanical shift, the function block 510_2 reads the image data of the LED head 503_2 from the A-group SRAM 514A_2 and the B-group SRAM 514B_2, converts the clock frequency, and writes the converted data in the field memory 515_1. Then, the function block 510_2 writes the image data according to the number of lines set in the image data register 510_4 in the field memory 515_2 cascade-connected to the field memory 515_1 while reading the image data from the field memory 515_1 in order of writing. Next, the function block 510_3 reads out the image data as L2DFMO [7:0] from the field memory 515_2 in order of writing. Here, the function block 510_3 starts to read the image date after writing the image data according to the number of lines set in the register 510_4. That is, the function block 510_3 causes a delay to the image data by delaying reading time of the image data in a unit of one line. In doing so, the image data of the LED head 503_2 is caused a delay of the writing timing by 17.5 mm in the sub-scanning direction in a unit of one line. The number of delay lines in the sub-scanning direction is selectable from the number of lines set in the register 510_4. That is, the number of lines to be delayed individually differs depending on parts precision and fluctuation of assembly of the LED head 503_2. However, the delay in a unit of one line can be controlled.

[0030] Also, the LED head 503_3 is shifted by 0.5 mm in the sub-scanning direction and is attached using the LED head 503_1 as a reference. Therefore, when the image data output from the A-group three SRAMs (514A_1 to 514A_3) and the B-group three SRAM (514B_1 to 514B_3) are simultaneously processed and transferred to the LED head 503_3, the LED head 503_3 is shifted by 0.5 mm in sub-scanning direction with respect to the LED head 503_1 and printed. To correct the mechanical shift, the function block 510_2 reads out the image data of the LED head 503_3 from the A-group SRAM 514A_3 and the B-group SRAM 514B_3, converts the clock frequency, and write the converted data in the field memory 515_3. Next, the function block 510_3 reads out the image data as L3DFMO [7:0] from the field memory 515_3 in order of writing. In dosing so, the image data of the LED head 503_3 is caused a delay of writing timing up to 0.5 mm in the sub-scanning direction in a unit of one line. The number of delay lines in the sub-scanning direction is selectable from the number of lines set in the register 510_4. That is, the number of lines to be delayed individually differs depending on the parts precision and the fluctuation of assembly of the LED head 503_3. However, the delay in a unit of one line can be controlled.

[0031] Next, an output via an image data output unit (driver) 519 of the function block 510_3 will be described. The function block 510_3 outputs the image data for the LED head 503_1 and the image data for the LED heads 503_2 and the LED head 503_3 via the image data delaying units 515_1 to 3 to the LED heads 503_1 to 3 via the image data output unit 519 with a control signal. Here, the function block 510_3 selects the data at both edges, and outputs. Note that the output of the image data to the LED head data may be performed by other method depending on a specification of the LED head.

[0032] Next, the LED heads 503_1 to 503_3 will be described. The LED heads 503_1 to 503_3 are binary writing units having a larger resolution than the scanning unit (sensor 101 of the scanning unit 100). For example, when the resolution of the sensor 101 of the scanning unit 100 is 600 dpi, the resolution of the LED heads 503_1 to 503_3 is 1200 dpi or more, for example. The function block 510_2 reads out the pixel data from SRAMs in A-group and B-group on a clock frequency that is twice that of writing; makes the read-out pixel data to be 1200 dpi and makes the LSYC signal to be a frequency that matches 1200 dpi (which is a half of 600 dpi). Therefore, the data that is input as 600 dpi is converted into data 1200 dpi so as to be written into.

[0033] Next, an amount of light correction RAM unit 516 will be described. The LED heads 503_1 to 503_3 is equipped with an amount of light correction ROM in which correction data of each LED element and correction data of each LED array chip are stored in order to correct fluctuation of the amount of light of each LED element. First, the IC 510 reads out the amount of light correction data of the LED head 503_1 when a power source is turned on, performs serial/parallel conversion, and stores the converted data as correction data of HOSEID [7:0] in a unit of 8 bits in the amount of light correction RAM unit 516. After storing the all correction data in the amount of light correction RAM unit 516, the IC 510 reads out the correction data from the amount of light correction RAM 516, and again transfers the read data to the LED head 503_1. The IC 510 performs this operation with respect to the LED heads 503_2 and 503_3 in a similar manner one by one. The LED heads 503_1 to 503_3 are configured to hold the correction data transferred from the IC 510 in its inside unless the power source is turned off.

[0034] Next, the system control unit (condition setting unit) 302 will be described. The system control unit 302 sets a writing condition to the LED writing control circuit 502 by inputting a control signal LDATA [7:0], an address LADR [5:0], a latch signal VDBCS, and a P sensor pattern signal SGATE_N into the IC 510. Note that the register 510_4 is connected to the function blocks 510_1 to 3, and stores setting such as the number of delay lines input via the operating unit 400 and the system control unit 302, the lighting time (duty) and the lighting position (lighting pattern) described below. Also, a plurality of register 510_4 may be provided in accordance with a type of storing data.

[0035] Next, coding (multiplying) of the pixel data will be described in detail. FIG. 4 is a diagram illustrating an example of coding (multiplying) of the pixel data. The function block 510_2 codes the pixel data at an overlapped portion of the LED heads 503_1 to 503_3 in a manner as illustrated in FIG. 4. For example, when black image data is "1" and white image data is "0" in binary of 600 dpi, the function block 510_2 causes the black image data to be "1111b" and the white image data to be "0000b" in 16 values of 1200 dpi. Further, the function block 510_2 is, other than the above two patterns, capable of coding the pixel data to be "0001b" in a case where only one dot is lightened among four dots, "0011b" in a case where two dots are lightened among the four dots, and "0111b" in a case where three dots are lightened among four dots in the pixel at the overlapping portion between the LED heads. The bit array of coding is, as illustrated in FIG. 4, from the lower bit, one data value, two data values, three data values, and four data values. Also, the function block 510_2 codes and controls the pixels of both end portions of the image output by the LED head 503_2 in accordance with the setting of the register 510_4 input via the operating unit 400.

[0036] FIG. 5A is a diagram illustrating an outline of an arrangement of the LED heads 503_1 to 503_3. FIG. 5B is an enlarged view of an overlapped portion between the LED head 503_1 and the LED head 503_2 of FIG. 5A. FIG. 5C is a diagram of resolution that is converted from 600 dpi to 1200 dpi. As illustrated in FIG. 5A, focusing on the overlapped portion between the LED head 503_1 and the LED head 503_2, when a grayscale image is output, a black streak occurs in the sub-scanning direction because the LED head 503_1 and the LED head 503_2 are overlapped. This black streak is illustrated in FIG. 5B by density. In FIG. 5B, the density of a portion where a waveform is fallen becomes high because the density of adjacent images is close, and therefore the black streak occurs in appearance.

[0037] When the image is simply expressed in binary, only one of printing the image data or not printing the image data (data 1 or 0) can be performed, and it is difficult to control an uneven amount of light (streak) of the overlapped portion of the LED heads. Meanwhile, if the image data is converted into multiple values, the amount of the image data in the overlapped portion of the LED heads can be changed. As a concrete example illustrated in FIG. 5C, if the transfer resolution to the LED head is caused to be an integral multiple (double, here) such as 1200 dpi, with respect to an input resolution of 600 dpi, the pixel at the overlapped portion between the LED heads becomes four pixels at 1200 dpi that is four times compared with the one pixel at 600 dpi, whereby the resolution is improved. In this way, if the image data is converted into multiple values from binary to 16 values, one data in binary becomes four data in binary, so that it becomes possible to control four pixel data value (lightening pattern) instead of controlling an overlapped correction in the slighting time (duty), or amount of light correction data of one pixel. FIG. 5C illustrates a case of printing two pixels as one in four pixels at the overlapped portion. Depression of the density in the overlapped portion is reduced, and the black streak becomes less remarkable in appearance.

[0038] Further, in the control of the present embodiment, the LED head employs a specification of printing density (resolution) of 1200 dpi. In actual operation control, first, overlapped image data is coded into two patterns (0000b and 1111b); and a grayscale image is output while an input image with 1200 dpi that has been converted from 600 dpi is maintained. As a result, if a white streak occurs in the image at the overlapped portion, the image data is moved in the main-scanning direction by writing control, and adjustment is carried out in such a way that the image data is output until the level where a black streak occurs instead of a white streak. When the overlapped part becomes less than one pixel, this time unevenness is made difficult to see by reducing printing of the pixel at the overlapped portion and by decreasing the density of the black streak.

[0039] Further, it is possible to further suppress the uneven amount of light at the overlapped portion by changing a lighting time (duty). FIGS. 6A to 6D are diagrams illustrating an example of the pixel data and lighting time (duty), and patterns. First, as illustrated in FIG. 6A, assume that the one pixel with 600 dpi is lightened during a lighting time (duty) 10% of the main scanning time. By the resolution (pixel density) conversion from 600 dpi to 1200 dpi, the one pixel can be divided into four pixels of "two pixels in the main-scanning direction x two pixels in the sub-scanning direction". As illustrated in FIG. 6B, the lighting time (duty) becomes 2.5%a per pixel, where the lighting time (duty) of the four pixels as a total is 10%, and all pixels are equally lightened.

[0040] Here, when one in four pixels is lightened in accordance with the resolution conversion, the pattern 2 illustrated in FIG. 6C is selected. There are four patterns in the pattern 2: a first pattern for lightening an upper left pixel (called first pixel), a second pattern for lightening an upper right pixel (called second pixel), a third pixel for lightening a lower left pixel (called third pixel), and a fourth pattern for lightening a lower right pixel (called fourth pixel). Where the lighting time (duty) of the first pixel is 1%, the lighting time (duty) of the second pixel is 2%, the lighting time (duty) of the third pixel is 3%, and the lighting time (duty) of the fourth pixel is 4%, as illustrated in FIG. 6D, it becomes possible to control the density more specifically depending on which pixel is selected from the first to fourth pixels, that is, which pattern is selected from the first to fourth patterns when one in four pixels is lightened. As described above, more specific control in a unit of one pixel at the overlapped portion becomes possible by the matrix of a ration between the print pattern and the lighting time.

[0041] Note that, in the above-described embodiment, the image forming apparatus has been exemplarily described by being applied to an MFP that has at least two of a copy function, a printer function, and a scanner function. However, the image forming apparatus of the embodiment can be applied to any image forming apparatus such as a copying machine and a printer.

[0042] According to the embodiment, writing with a higher resolution than an original image can be performed. A good-quality output image can easily be obtained.

[0043] Although the invention has been described with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

Claims

1. A writing device that receives a binary signal in accordance with image data, and writes an image based on the signal, comprising:

   a multiple-value unit (300) that outputs a multiple-value signal based on the received binary signal, the multiple value being an integral multiple of the binary; and
   a writing unit (500) that writes a binary image having a lager resolution than a resolution of the image data based on the multiple-value signal.

2. The writing device according to claim 1,
   wherein the writing unit (500) includes a plurality of writing array units (503_1, 503_2, 503_3) arranged in such a way that mutual end portions thereof are overlapped in a sub-scanning direction, and each of the plurality of writing array units (503_1, 503_2, 503_3) writes an image with a plurality of light sources, and
   the multiple-value unit (300) causes the multiple-value signal corresponding to the light source positioned at a portion where the plurality of writing array units (503_1, 503_2, 503_3) overlaps to be a signal based on a value stored in a storing unit (610) in advance.

3. The writing device according to claim 2, further comprising:

   a resolution conversion unit (300, 610) that converts resolution in such a way that a region on an image with a pixel indicated by the binary signal in accordance with the image data corresponds to a region on an image with a plurality of pixels indicated by the multiple-value signal,
   wherein the writing unit (500) writes a binary image in accordance with a conversion result converted by the resolution conversion unit.

4. The writing device according to claim 2 or 3,
   wherein the light source is of LED, and
   the storing unit stores a value that indicates which of the plurality of light sources corresponding to the multiple-value signal is lightened by the writing unit (500) to write an image.

5. The writing device according to claim 2 or 3,
   wherein the light source is of LED, and
   the storing unit (610) stores a value indicating a lightening time of the light source.

6. An image forming apparatus comprising the writing device according to any one of claims 1 to 5.

7. A writing method for a writing device, the method comprising:

   outputting a multiple-value signal based on a binary signal in accordance with image data, the multiple value being an integral multiple of the binary; and
   writing a binary image having a larger resolution than a resolution of the image data based on the multiple-value signal.

FIG.1

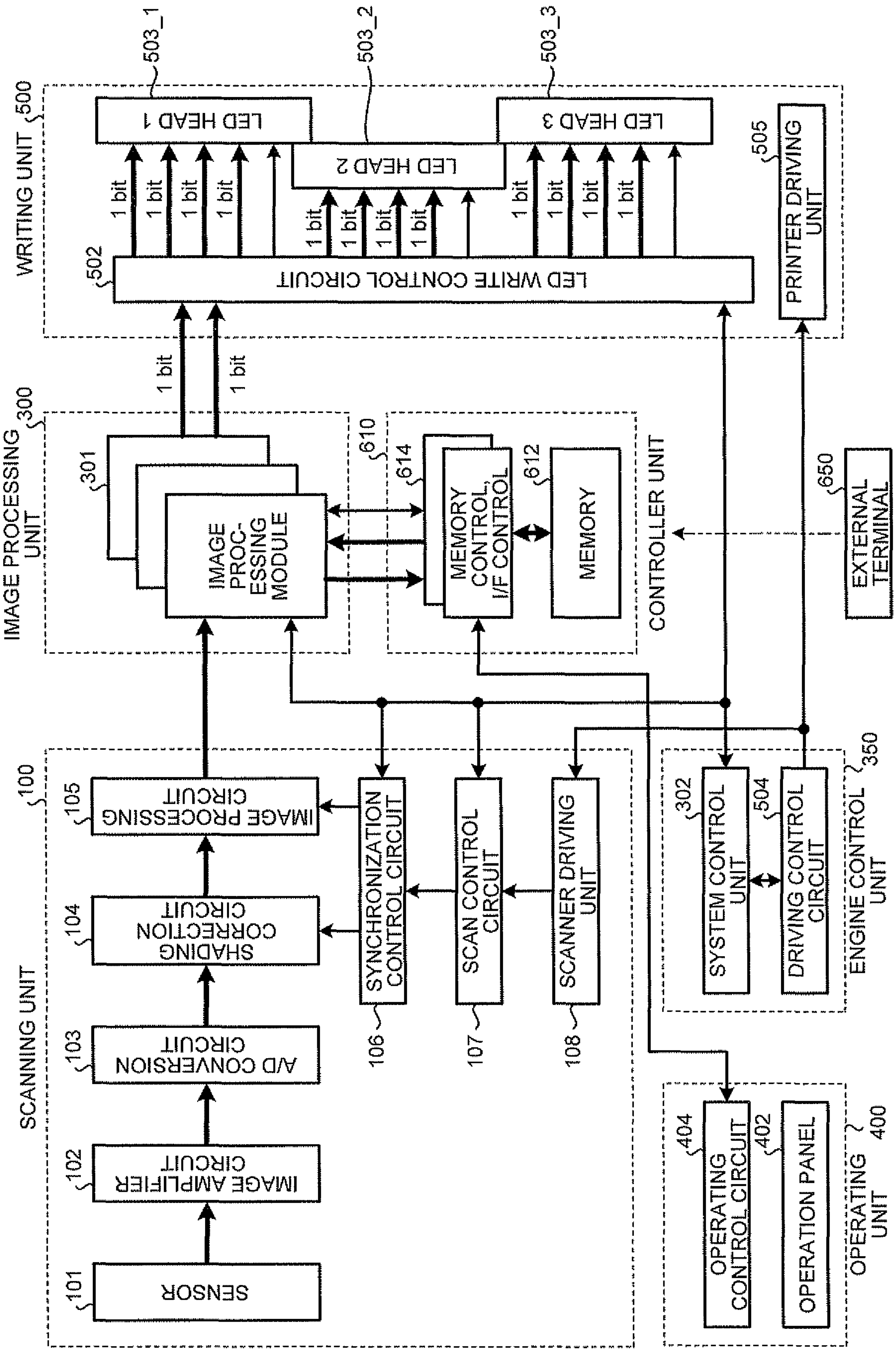

WRITING UNIT
500
LED HEAD 1
LED HEAD 2
LED HEAD 3
503_1
503_2
503_3
1 bit
LED WRITE CONTROL CIRCUIT
502
PRINTER DRIVING UNIT
505
IMAGE PROCESSING UNIT
300
301
IMAGE PROC-ESSING MODULE
610
614
MEMORY CONTROL, I/F CONTROL
612
MEMORY
CONTROLLER UNIT
650
EXTERNAL TERMINAL
SCANNING UNIT
100
101
SENSOR
102
IMAGE AMPLIFIER CIRCUIT
103
A/D CONVERSION CIRCUIT
104
SHADING CORRECTION CIRCUIT
105
IMAGE PROCESSING CIRCUIT
106
SYNCHRONIZATION CONTROL CIRCUIT
107
SCAN CONTROL CIRCUIT
108
SCANNER DRIVING UNIT
302
SYSTEM CONTROL UNIT
504
DRIVING CONTROL CIRCUIT
ENGINE CONTROL UNIT
350
404
OPERATING CONTROL CIRCUIT
402
OPERATION PANEL
OPERATING UNIT
400

FIG.2

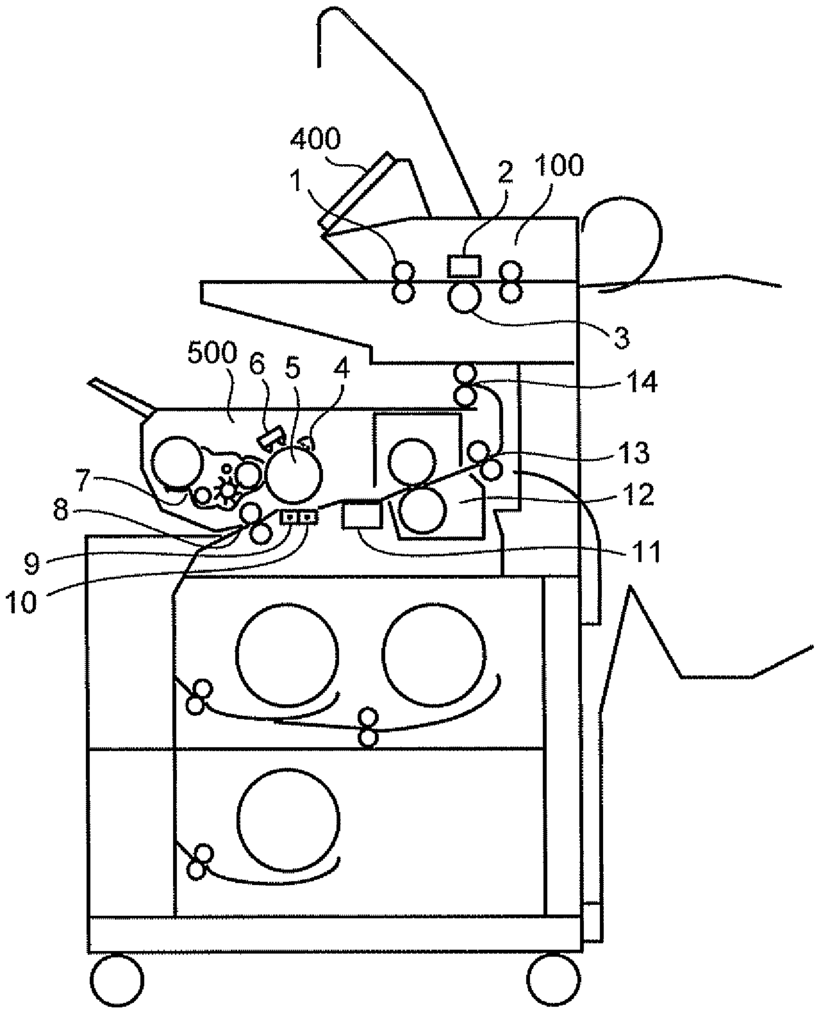
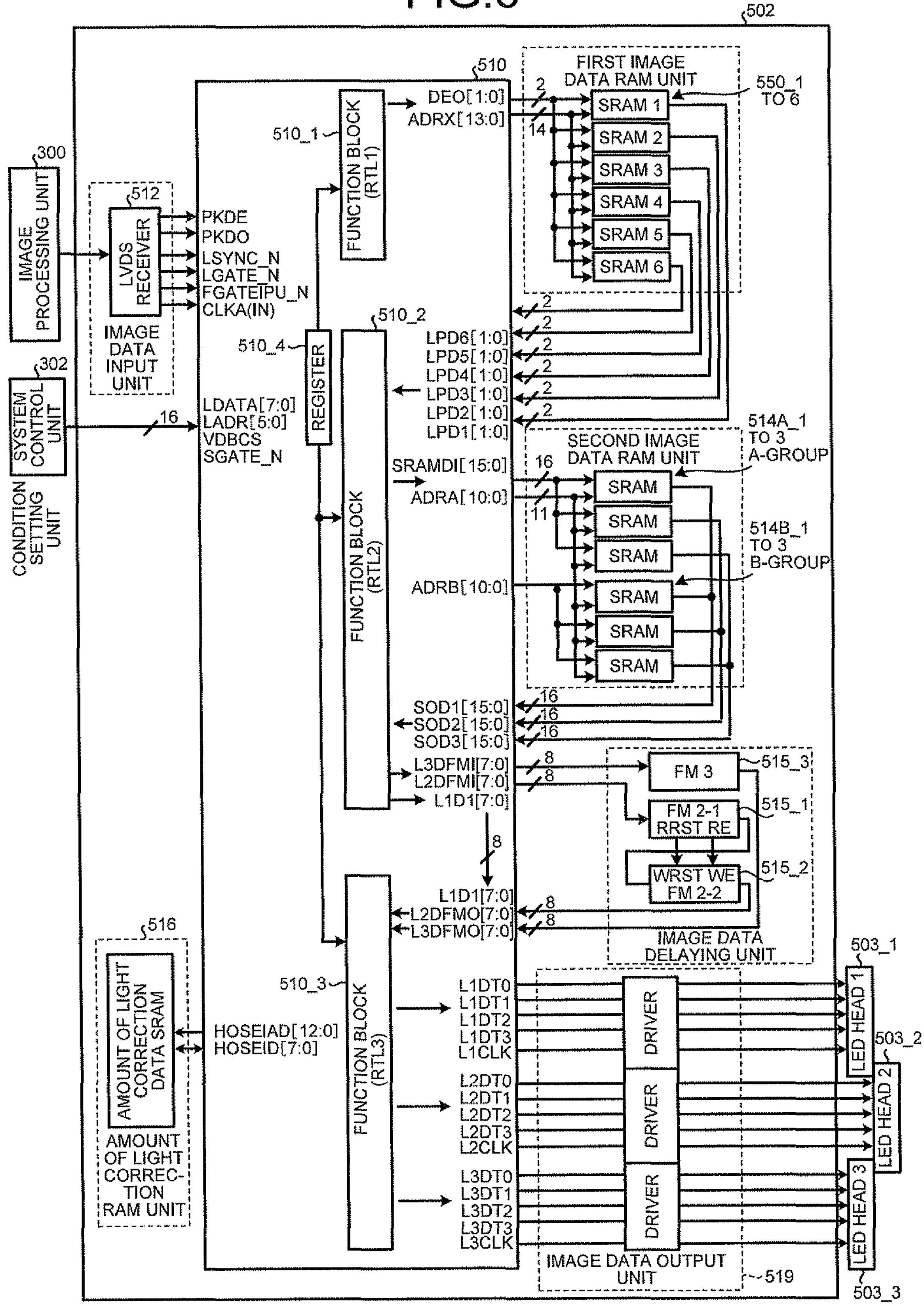


FIG.3



502
510
FIRST IMAGE DATA RAM UNIT
550_1 TO 6
DEO[1:0]
ADRX[13:0]
2
14
SRAM 1
SRAM 2
SRAM 3
SRAM 4
SRAM 5
SRAM 6
510_1
FUNCTION BLOCK (RTL1)
300
IMAGE PROCESSING UNIT
512
LVDS RECEIVER
PKDE
PKDO
LSYNC_N
LGATE_N
FGATEIPU_N
CLKA(IN)
IMAGE DATA INPUT UNIT
510_2
510_4
REGISTER
LPD6[1:0]
LPD5[1:0]
LPD4[1:0]
LPD3[1:0]
LPD2[1:0]
LPD1[1:0]
302
SYSTEM CONTROL UNIT
CONDITION SETTING UNIT
16
LDATA[7:0]
LADR[5:0]
VDBCS
SGATE_N
514A_1 TO 3 A-GROUP
SECOND IMAGE DATA RAM UNIT
SRAMDI[15:0]
ADRA[10:0]
11
SRAM
514B_1 TO 3 B-GROUP
FUNCTION BLOCK (RTL2)
ADRB[10:0]
SOD1[15:0]
SOD2[15:0]
SOD3[15:0]
L3DFMI[7:0]
L2DFMI[7:0]
L1D1[7:0]
8
FM 3
515_3
FM 2-1
RRST RE
515_1
WRST WE
FM 2-2
515_2
L2DFMO[7:0]
L3DFMO[7:0]
IMAGE DATA DELAYING UNIT
516
AMOUNT OF LIGHT CORRECTION DATA SRAM
AMOUNT OF LIGHT CORREC-TION RAM UNIT
HOSEIAD[12:0]
HOSEID[7:0]
510_3
FUNCTION BLOCK (RTL3)
L1DT0
L1DT1
L1DT2
L1DT3
L1CLK
L2DT0
L2DT1
L2DT2
L2DT3
L2CLK
L3DT0
L3DT1
L3DT2
L3DT3
L3CLK
DRIVER
503_1
LED HEAD 1
503_2
LED HEAD 2
LED HEAD 3
503_3
IMAGE DATA OUTPUT UNIT
519

FIG.4

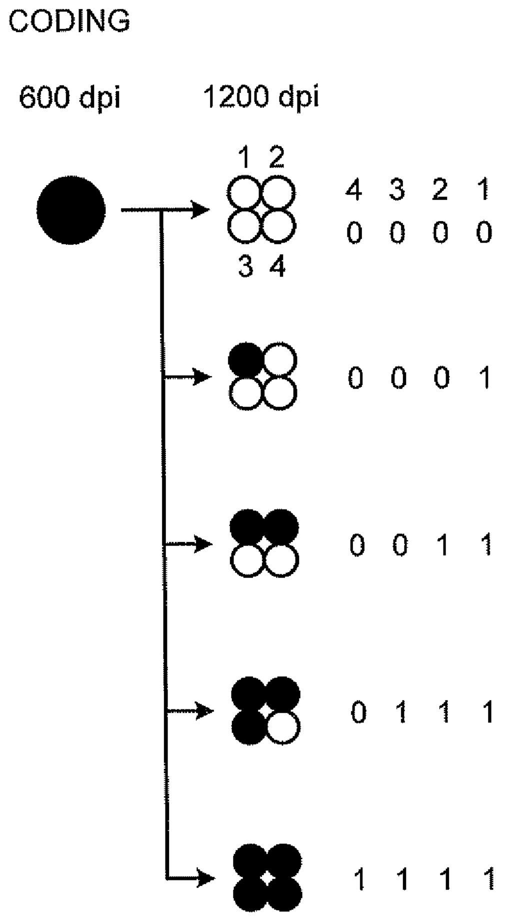


FIG.5A

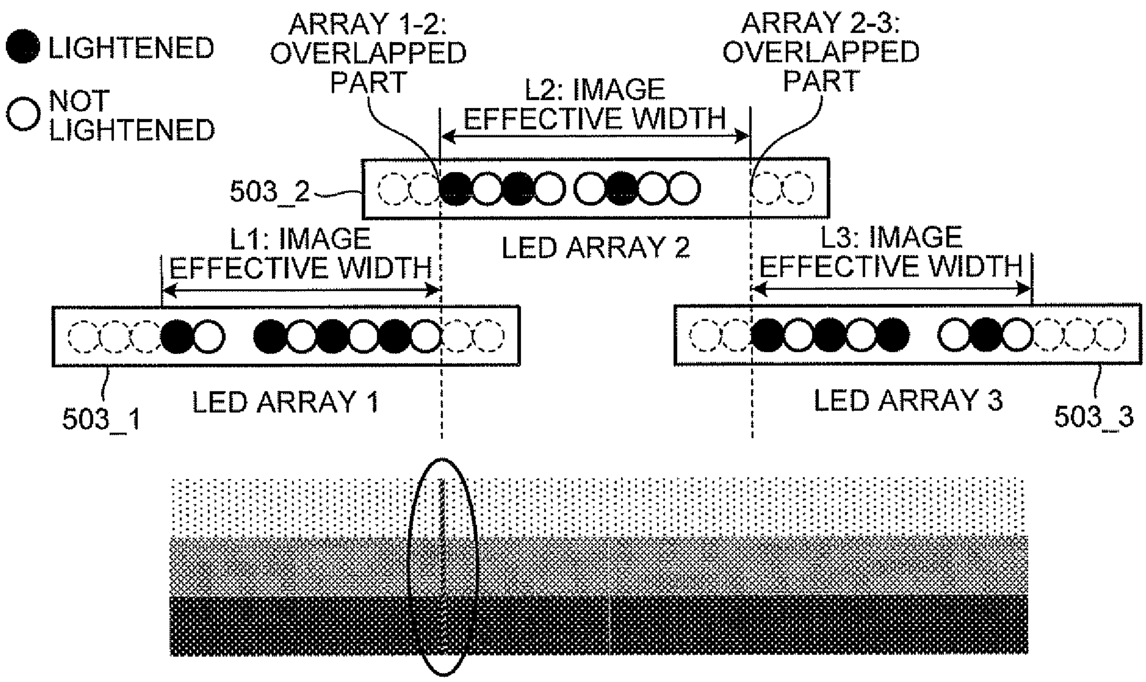


FIG.5B

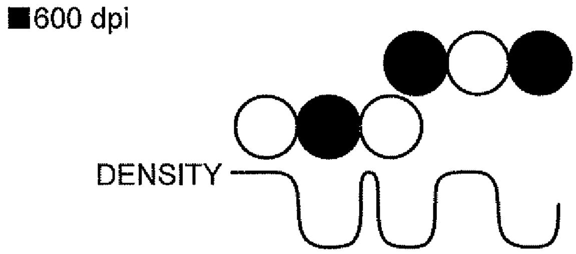


FIG.5C

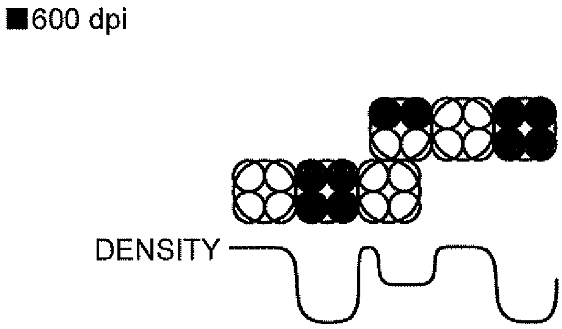


FIG.6A

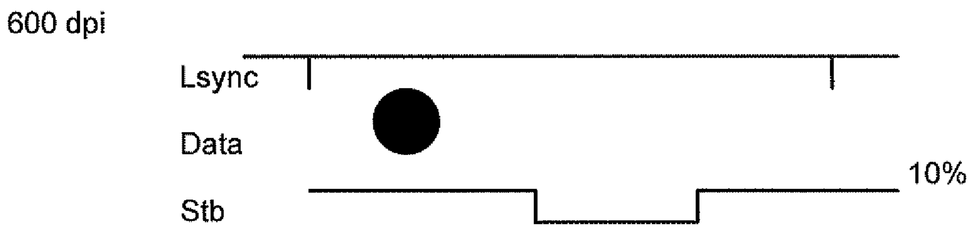


FIG.6B

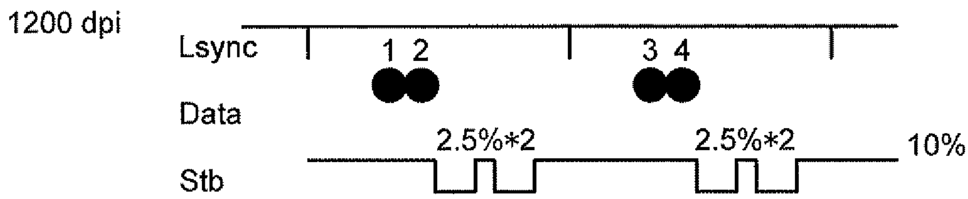


FIG.6C

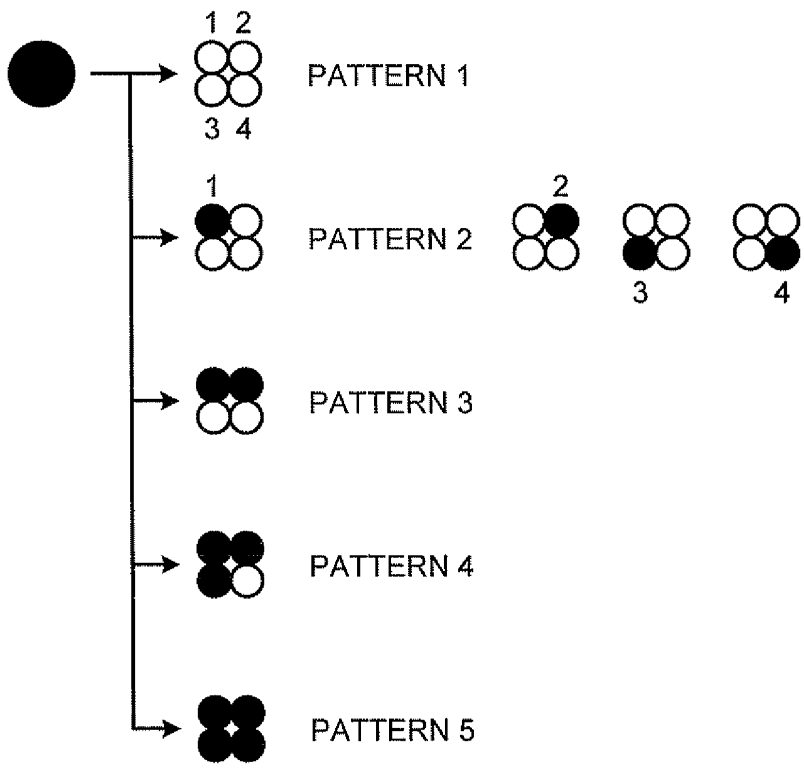
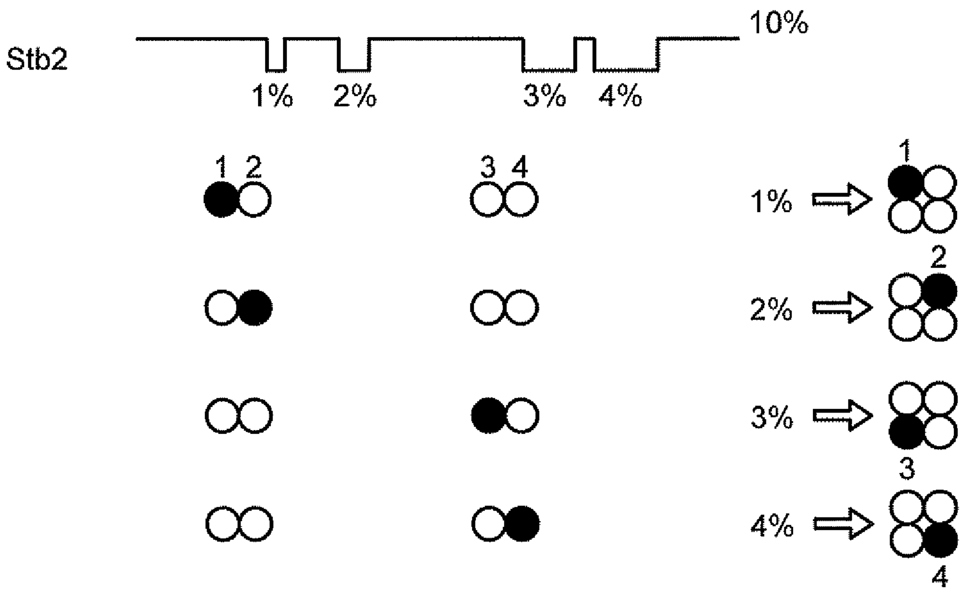


FIG.6D



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011202400 A **[0001]**
- JP 2012191982 A **[0001]**
- JP 2004122718 A **[0006]**