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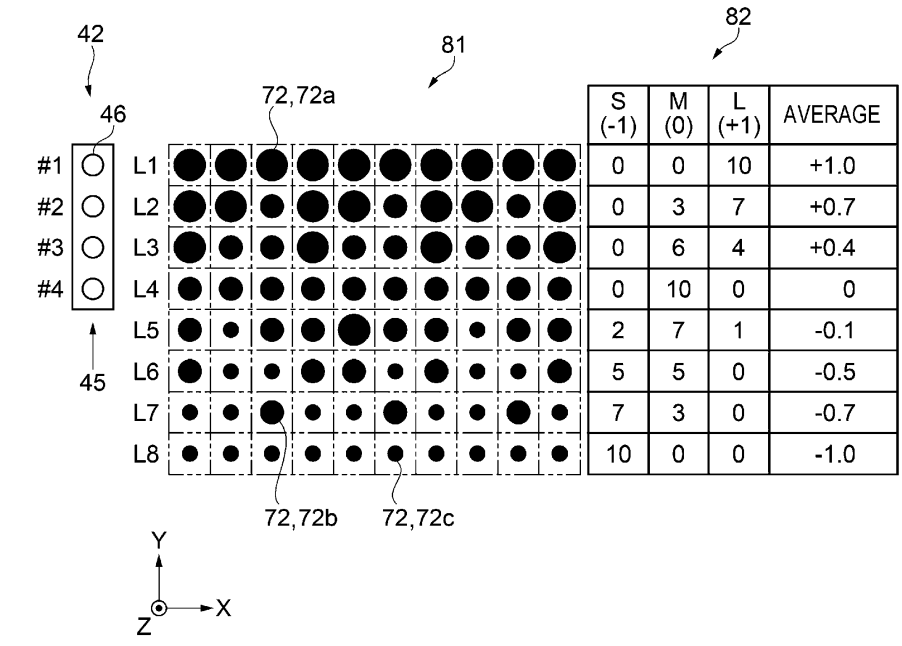
(54) PRINTING APPARATUS AND PRINTING METHOD

(57) A printing apparatus includes a medium transport portion configured to transport a recording medium in a transport direction, a discharge head configured to discharge liquid droplets each having one size among mutually different sizes onto the recording medium, a head moving portion configured to reciprocate the discharge head in a main scanning direction intersecting with the transport direction, a printer controller serving as a calculation portion configured to analyze the size of each of the liquid droplets and quantities with respect to the liquid droplets on the basis of image data corresponding to an image to be printed on the recording medium to calculate at least one adjustment value to be applied to discharge timing points at each of which a corresponding one of the liquid droplets is discharged, and a controller configured to change the discharge timing points on the basis of the at least one adjustment value.

FIG. 9



S (-1)	M (0)	L (+1)	AVERAGE
0	0	10	+1.0
0	3	7	+0.7
0	6	4	+0.4
0	10	0	0
2	7	1	-0.1
5	5	0	-0.5
7	3	0	-0.7
10	0	0	-1.0

EP 3 235 648 A1

Description

1. Technical Field

[0001] The present invention relates to a printing apparatus and a printing method.

2. Related Art

[0002] Heretofore, in bidirectional printing in which a discharge head configured to discharge liquid droplets (ink droplets) so as to allow the liquid droplets to form dots each having one of mutually different sizes is allowed to reciprocate in a width direction of a recording medium, an ink jet printing apparatus that forms images and/or the like on the recording medium has been well known. The landing positions on the recording medium with respect to the liquid droplets, discharged from the discharge head, differ in accordance with the sizes (masses) of the liquid droplets, and thus, when a liquid droplet having a size larger than a predetermined size is discharged, or a liquid droplet having a size smaller than the predetermined size is discharged, a discrepancy arises between its landing position in each of outward movements of the discharge head and its landing position in each of homeward movements of the discharge head. For example, in JP-A-2009-234071, there is disclosed a printing apparatus in which images to be printed are categorized into a group of large dot images, such as a barcode that is printed while a large dot size is being most frequently used, and a group of non-large dot images other than the large dot images, and the bidirectional printing is performed using adjustment values each applied to the adjustment of discrepancy amounts of landing positions with respect to a corresponding one of the group of large dot images and the group of non-large dot images. It is described in JP-A-2009-234071 that this configuration reduces the degradation of the quality of printed images due to the discrepancies between the landing positions of ink droplets in each of the outward movements and the landing positions of ink droplets in each of the homeward movements.

[0003] In the printing apparatus disclosed in JP-A-2009-234071, however, the adjustment applied to discharge timing points at which liquid droplets are discharged is made on only the two categories, one being the group of large dot images, the other one being the group of non-large dot images. Thus, the effect of correcting the discrepancies between the landing positions of liquid droplets discharged in each of the outward movements and the landing positions of liquid droplets discharged in each of the homeward movements is not sufficient, and thus, the effect of reducing the degradation of printing quality due to the landing position discrepancies is not sufficient.

SUMMARY

[0004] An advantage of some aspects of the invention is that a printing apparatus and a printing method are provided that enable the discrepancies between the landing positions of liquid droplets in each of the outward movements and the landing positions of liquid droplets in each of the homeward movements to be sufficiently reduced. The invention is embodied as the following application examples and an embodiment described later.

Application Example 1

[0005] A printing apparatus according to this application example includes a medium transport portion configured to transport a recording medium in a transport direction, a discharge head configured to discharge liquid droplets each having one size among mutually different sizes onto the recording medium, a head moving portion configured to reciprocate the discharge head in a main scanning direction intersecting with the transport direction, a calculation portion configured to analyze the size of each of the liquid droplets and quantities with respect to the liquid droplets on the basis of image data corresponding to an image to be printed on the recording medium to calculate at least one adjustment value to be applied to discharge timing points at each of which a corresponding one of the liquid droplets is discharged, and a controller configured to change the discharge timing points on the basis of the at least one adjustment value.

[0006] According to this application example, the printing apparatus analyzes the size of each of the liquid droplets and quantities with respect to the liquid droplets on the basis of the image data to calculate at least one adjustment value to be applied to discharge timing points at each of which a corresponding one of the liquid droplets is discharged, and changes the discharge timing points on the basis of the at least one adjustment value. With this configuration, the discrepancies between the landing positions in each of the outward movements and the landing positions in each of the homeward movements are reduced, and thus, the degradation of printing quality due to the landing position discrepancies is reduced. Accordingly, the printing apparatus that achieves the improvement of the printing quality is provided. Application Example 2

[0007] In the above printing apparatus according to application example 1, preferably, the at least one adjustment value is calculated for each of at least one predetermined region, and the discharge timing points are changed for each of the at least one predetermined region.

[0008] According to this application example, based on the at least one adjustment value having been calculated for each of the at least one predetermined region, the printing apparatus controls the discharge timing points for each of the at least one predetermined region, and thus, the landing position discrepancies are reduced,

and as a result, the printing quality is improved.

Application Example 3

[0009] In the above printing apparatus according to application example 2, preferably, each of the at least one predetermined region corresponds to a set of one or more raster lines in each of which dots formed by liquid droplets among the liquid droplets align in the main scanning direction.

[0010] According to this application example, based on the at least one adjustment value having been calculated for each of sets of one or more raster lines, the printing apparatus changes the discharge timing points for liquid droplets forming the each of the sets of one or more raster lines, and thus, the landing position discrepancies are further reduced. Application Example 4

[0011] A printing method according to this application example is a printing method for a printing apparatus including a medium transport portion configured to transport a recording medium in a transport direction, a discharge head configured to discharge liquid droplets each having one size among mutually different sizes onto the recording medium, and a head moving portion configured to reciprocate the discharge head in a main scanning direction intersecting with the transport direction, and includes analyzing the size of each of the liquid droplets and quantities with respect to the liquid droplets on the basis of image data corresponding to an image to be printed on the recording medium, calculating at least one adjustment value to be applied to discharge timing points at each of which a corresponding one of the liquid droplets is discharged, and changing the discharge timing points on the basis of the at least one adjustment value.

[0012] According to this application example, in the above printing method for such a printing apparatus, the size of each of the liquid droplets and quantities with respect to the liquid droplets are analyzed on the basis of image data corresponding to an image to be printed on the recording medium, and at least one adjustment value to be applied to discharge timing points at each of which a corresponding one of the liquid droplets is discharged is calculated. Further, the discharge timing points are changed on the basis of the at least one adjustment value. Through this method, the discrepancies between the landing positions in each of the outward movements and the landing positions in each of the homeward movements are reduced, and thus, the degradation of printing quality due to the landing position discrepancies is reduced. Accordingly, the printing method that achieves the improvement of the printing quality is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings, wherein like numbers reference like elements.

Fig. 1 is a schematic diagram illustrating the outline of the overall configuration of a printing apparatus according to an embodiment of the invention.

Fig. 2 is a cross-sectional view of a discharge head included in the printing apparatus illustrating the internal configuration of the discharge head.

Fig. 3 is an electric block diagram illustrating an electric configuration of the printing apparatus.

Fig. 4 is a diagram illustrating image processing for printing images, according to the embodiment.

Fig. 5 is a diagram illustrating the landing position of a liquid droplet that forms a middle-size dot, according to the embodiment.

Fig. 6 is a diagram illustrating the landing position of a liquid droplet that forms a large-size dot, according to the embodiment.

Fig. 7 is a diagram illustrating the landing position of a liquid droplet that forms a small-size dot, according to the embodiment.

Fig. 8 is a flowchart illustrating a printing method according to the embodiment.

Fig. 9 is a diagram illustrating a method for analyzing dots, according to the embodiment.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0014] Hereinafter, an embodiment of the invention will be described with reference to the drawings. Here, in each of figures to be referred to in the following description, in order to allow the size of each of layers and members to be a recognizable degree of size, the scale ratio of the each of the layers and members is allowed to be different from an actual scale ratio.

[0015] Further, in each of Figs. 1, 2, 5 to 7, and 9, for the convenience of description, an X-axis, a Y-axis, and a Z-axis are illustrated as three mutually orthogonal axes, and the tip side of an arrow indicating the direction of each of the axes corresponds to the "+ side" of the each of the axes, and the base side of the arrow corresponds to the "- side" of the each of the axes. Further, in the following description, a direction parallel to the X-axis will be referred to as an "X-axis direction", a direction parallel to the Y-axis will be referred to as a "Y-axis direction", and a direction parallel to the Z-axis will be referred to as a "Z-axis direction.

Embodiment

Outline Configuration of Printing Apparatus

[0016] Fig. 1 is a schematic diagram illustrating the outline of the overall configuration of a printing apparatus according to this embodiment of the invention.

First, the outline configuration of a printing apparatus 100, the printing apparatus according to this embodiment, will be described referring to Fig. 1. Here, in this embodiment, the description will be made by way of an example in which the printing apparatus 100 is an ink jet

printing apparatus that performs printing onto a recording medium 95 by forming images and/or the like on the recording medium 95.

[0017] As shown in Fig. 1, the printing apparatus 100 includes a medium transport portion 20, a medium closely-contact portion 60, a printing portion 40, a drying unit 27, a washing unit 50, and any other component. Further, the printing apparatus 100 includes a controller 1, and this controller 1 controls each of the above components. Each of the above components included in the printing apparatus 100 is secured to a frame portion 90. Moreover, the printing apparatus 100 includes an image processing device 110 (see Fig. 3), and this image processing device 110 will be described later.

[0018] The medium transport portion 20 is a portion that transports the recording medium 95 in a transport direction (in the +Y-axis direction in the printing portion 40). The medium transport portion 20 includes a medium feeding portion 10, transport rollers 21 and 22, a transport belt 23, a belt rotation roller 24, a belt driving roller 25, transport rollers 26 and 28, and a medium collection portion 30. First, a path for transporting the recording medium 95 from the medium feeding portion 10 to the medium collection portion 30 will be described.

[0019] The medium feeding portion 10 is a portion that feeds the recording medium 95, on which images are to be formed, to the side of the printing portion 40. Further, cloth, such as cotton, wool, or polyester, is used as the recording medium 95. The medium feeding portion 10 includes a feeding shaft portion 11 and a shaft bearing portion 12. The feeding shaft portion 11 is formed in a cylindrical hollow shape or a cylindrical column shape, and is disposed so as to be rotatable in its circumference direction. The recording medium 95 is a belt- or strip-shaped recording medium, and is wound in a roll shape around the feeding shaft portion 11. The feeding shaft portion 11 is attached to the shaft bearing portion 12 so as to be attachable/detachable. These configurations enable the recording medium 95, which is in a state of being wound around the feeding shaft portion 11 in advance, to be attached to the shaft bearing portion 12 together with the feeding shaft portion 11. It should be noted here that the wound direction and the rotation of the recording medium 95 being retained by the medium feeding portion 10 are not limited to the wound direction and the rotation direction shown in Fig. 1 that are just examples. The configuration may be made such that the feeding shaft portion 11 is rotated in a direction reverse to that shown in Fig. 1, and the recording medium 95 is fed from a roll formed of the recording medium 95 in a state of being wound so as to allow its recorded face to face the inside of the roll.

[0020] The shaft bearing portion 12 rotatably supports both shaft-direction ends of the feeding shaft portion 11. The medium feeding portion 10 includes a rotation driving portion (not illustrated) that drivingly rotates the feeding shaft portion 11. The rotation driving portion allows the feeding shaft portion 11 to rotate in a direction in which the recording medium 95 is unwound and fed. The operation of the rotation driving portion is controlled by the controller 1. The transport rollers 21 and 22 relay the recording medium 95 from the medium feeding portion 10 to the transport belt 23.

[0021] The transport belt 23 transports the recording medium 95 in a transport direction (in the +Y-axis direction). Describing in details, the transport belt 23 is formed in an endless state by allowing the both ends of its belt- or strip-shaped belt to be coupled to each other, and each of the ends of the belt is hung on a corresponding one of the belt rotation roller 24 and the belt driving roller 25. The transport belt 23 is kept in a state in which a predetermined tensile force is activated so as to allow the portion between the belt rotation roller 24 and the belt driving roller 25 to be kept in parallel to the floor face 99. An adhesive layer 29 is disposed on a surface (support face) 23a of the transport belt 23. The adhesive layer 29 allows the recording medium 95 to be adhered to the adhesive layer 29 itself. The recording medium 95 is fed from the transport roller 22, and then is brought into close contact with the adhesive layer 29 by the medium closely-contact portion 60, which will be described later. The transport belt 23 supports and retains the recording medium 95, which is in such a state described above. This configuration enables a stretchable material, such as cloth, to be handled as the recording medium 95.

[0022] The belt rotation roller 24 and the belt driving roller 25 support an inner circumference face 23b of the transport belt 23. Here, the configuration may be made such that a support portion for supporting the transport belt 23 is disposed between the belt rotation roller 24 and the belt driving roller 25.

[0023] The belt driving roller 25 includes a motor (not illustrated) that drivingly rotates the belt driving roller 25. When the belt driving roller 25 is drivingly rotated, the transport belt 23 rotates along with the rotation of the belt driving roller 25, and this rotation of the transport belt 23 drives the rotation of the belt rotation roller 24. The recording medium 95, which is supported by the transport belt 23, is transported by the rotation of the transport belt 23 in the predetermined transport direction (in the +Y-axis direction), and images are formed on the recording medium 95 by the printing portion 40, which will be described later.

[0024] In this embodiment, the recording medium 95 is supported at the side where a surface 23a of the transport belt 23 faces the printing portion 40 (i.e., at the +Z-axis side), and the recording medium 95 is transported together with the transport belt 23 from the side of the belt rotation roller 24 to the side of the belt driving roller 25 (i.e., in the +Y-axis direction). Further, only the transport belt 23 is moved from the side of the belt driving roller 25 to the side of the belt rotation roller 24 (i.e., in the -Y-axis direction) at the side where the surface 23a of the transport belt 23 faces the washing unit 50 (i.e., at the -Z-axis side). It should be noted here that, although it has been described above that the transport belt 23

includes the adhesive layer 29, which allows the recording medium 95 to be adhered to the adhesive layer 29 itself, the transport belt is not limited to such a configuration. For example, the transport belt may be a transport belt employing an electrostatic absorption method that allows a medium to be absorbed to a belt by means of static electricity.

[0025] The transport roller 26 allows the recording medium 95, on which the images have been formed, to be released from the adhesive layer 29 of the transport belt 23. The transport rollers 26 and 28 relay the recording medium 95 from the transport belt 23 to the medium collection portion 30.

[0026] The medium collection portion 30 collects the recording medium 95 having been transported by the medium transport portion 20. The medium collection portion 30 includes a winding shaft portion 31 and a shaft bearing portion 32. The winding shaft portion 31 is formed in a cylindrical hollow shape or a cylindrical column shape, and is disposed so as to be rotatable in the circumference direction. The belt- or strip-shaped recording medium 95 is wound in a roll shape around the winding shaft portion 31. The winding shaft portion 31 is attached to the shaft bearing portion 32 so as to be attachable/detachable. This configuration enables the recording medium 95 in a state of having being wound by the winding shaft portion 31 to be detached together with the winding shaft portion 31.

[0027] The shaft bearing portion 32 supports both shaft-line direction ends of the winding shaft portion 31 so as to allow the winding shaft portion 31 to be rotatable. The medium collection portion 30 includes a rotation driving portion (not illustrated) for drivingly rotating the winding shaft portion 31. The rotation driving portion rotates the winding shaft portion 31 in a direction in which the recording medium 95 is wound. The operation of the rotation driving portion is controlled by the controller 1. It should be noted here that the wound direction and the rotation direction of the recording medium 95 being retained by the medium collection portion 30 are not limited to the wound direction and the rotation direction shown in Fig. 1 that are just examples. The configuration may be made such that the winding shaft portion 31 is rotated in a direction reverse to that shown in Fig. 1, and the recording medium 95 is wound so as to allow its recorded face to face the inside of a roll formed of the recording medium 95.

[0028] Next, individual components disposed along the medium transport portion 20 will be described.

[0029] The medium closely-contact portion 60 is a component that brings the recording medium 95 into close contact with the transport belt 23. The medium closely-contact portion 60 is disposed at the upstream side (the -Y-axis side) of the printing portion 40. The medium closely-contact portion 60 includes a pressing roller 61, a pressing roller driving portion 62, and a roller support portion 63. The pressing roller 61 is formed in a cylindrical hollow shape or a cylindrical column shape so as to be rotatable in its circumference direction. The pressing roller 61 is disposed so as to allow its shaft-line direction to intersect with the transport direction to be rotated in the transport direction. The roller support portion 63 is disposed at the side of the inner circumference face 23b of the transport belt 23, that is, at the side opposite the pressing roller 61 with the transport belt 23 being interposed between the roller support portion 63 and the pressing roller 61.

[0030] The pressing roller driving portion 62 moves the pressing roller 61 in the transport direction (in the +Y-axis direction) and in the direction reverse to the transport direction (i.e., in the -Y-axis direction) while pressing the pressing roller 61 toward the lower side (the -Z-axis side) in the vertical direction. The recording medium 95 having been superposed on the transport belt 23 is pressed onto the transport belt 23 between the pressing roller 61 and the roller support portion 63. This configuration enables the recording medium 95 to be certainly adhered to the adhesive layer 29, which is disposed on the surface 23a of the transport belt 23, and as a result, the occurrence of the floating of the recording medium 95 on the transport belt 23 is eliminated or minimized.

[0031] The printing portion 40 is disposed at the upper side (the +Z-axis side) relative to the disposition position of the transport belt 23. The printing portion 40 includes a discharge head 42, a carriage 43, a head moving portion 41, and any other component. The discharge head 42 discharges inks onto the recording medium 95 mounted on the transport belt 23. The carriage 43 includes a discharge head 42 mounted therein. The head moving portion 41 moves the carriage 43. The discharge head 42 includes a nozzle plate 44. The nozzle plate 44 includes a plurality of nozzle rows 45 formed therein. For example, four nozzle rows 45 are formed in the nozzle plate 44, and through each of the four nozzle rows 45, a corresponding one of mutually different colors (for example, cyan: C, magenta: M, yellow: Y, and black: K) is discharged. The nozzle plate 44 is located so as to face the recording medium 95, which is transported by the transport belt 23.

[0032] The head moving portion 41 reciprocates the discharge head 42 (the carriage 43) in a main-scanning direction intersecting with the transport direction of the recording medium 95 (i.e., in a width direction of the recording medium 95 (i.e., in the X-axis direction)). The carriage 43 is supported by a guide rail (not illustrated) disposed along the X-axis direction, and is configured to be capable of being reciprocated in the +X-axis direction and the -X-axis direction by the head moving portion 41. Non-limiting examples of an adoptable mechanism for the head moving portion 41 include a mechanism that allows ball screws and ball nuts to be combined with each other, and a linear guide mechanism. Moreover, the head moving portion 41 includes a motor (not illustrated) serving as a power source for moving the carriage 43 along the X-axis direction. When the motor is driven by the control of the controller 1, the discharge head 42 is recipro-

cated together with the carriage 43 along the X-axis direction. Further, the printing portion 40 includes a linear encoder 91 (see Fig. 3). The linear encoder 91 detects the position of the carriage 43 along the main-scanning direction.

[0033] The drying unit 27 is disposed between the transport roller 26 and the transport roller 28. The drying unit 27 is a unit for drying inks having been discharged on the recording medium 95, and, for example, an IR heater is included in the drying unit 27. Driving this IR heater enables the inks having been discharged on the recording medium 95 to be dried in a short period of time. This configuration enables the belt- or strip-shaped recording medium 95, on which the images and/or the like have been formed, to be wound around the winding shaft portion 31.

[0034] The washing unit 50 is disposed between the belt rotation roller 24 and the belt driving roller 25 in the Y-axis direction. The washing unit 50 includes a washing portion 51, pressing portions 52, and moving portions 53. The moving portions 53 move the washing unit 50 along the floor face 99 in a unified manner, and fix the washing unit 50 at a predetermined position.

[0035] The pressing portions 52 are, for example, lifting/lowering devices each constituted by an air cylinder 56 and a ball bush 57, and include the washing portion 51 mounted on the upper portions of the pressing portions 52 themselves. Further, the pressing portions 52 bring the washing portion 51 into contact with the surface 23a of the transport belt 23. The transport belt 23 is moved from the belt driving roller 25 toward the belt rotation roller 24 while being hung between the belt driving roller 25 and the belt rotation roller 24 in a state of a tensile force being applied. The washing portion 51 washes the surface (support face) 23a of the transport belt 23 from the below (i.e., from the -Z-axis side).

[0036] The washing portion 51 includes a washing tank 54, a washing roller 58, and a blade 55. The washing tank 54 is a tank for storing therein a wash liquid for use in washing inks and/or foreign materials having been adhered to the surface 23a of the transport belt 23, and the washing roller 58 and the blade 55 are disposed inside the washing tank 54. For the wash liquid, for example, water or a water-soluble solvent (such as an alcohol aqueous solution) may be used as the wash liquid, and a surface-active agent or an antifoaming agent may be added as needed.

[0037] When the washing roller 58 rotates, the wash liquid is supplied to the surface 23a of the transport belt 23 and the washing roller 58 slides relative to the transport belt 23 in a state of being in contact with the surface 23a of the transport belt 23. Through this operation, foreign materials having been adhered to the transport belt 23, such as inks and fibers of cloth serving as the recording medium 95, are removed by the washing roller 58.

[0038] The blade 55 is made of, for example, a flexible material, such as silicon rubber. The blade 55 is disposed at the downstream side of the washing roller 58 in the transport direction of the transport belt 23. The transport belt 23 and the blade 55 slide relative to each other in a state of being in contact with each other, and this operation allows the wash liquid remaining on the surface 23a of the transport belt 23 to be removed.

Discharge Head

[0039] Fig. 2 is a cross-sectional view of the discharge head 42 illustrating the internal configuration of the discharge head 42. Next, the configuration of the discharge head 42 will be described referring to Fig. 2.

[0040] As shown in Fig. 2, the discharge head 42 includes the nozzle plate 44, and nozzles 46 are formed in the nozzle plate 44. Further, at the upper side (+Z-axis side) of the nozzle plate 44, each of cavities 47 is formed at a position facing a corresponding one of the nozzles 46 so as to communicate with the corresponding one of the nozzles 46. Further, each of the cavities 47, which communicate with the respective nozzles 46, is supplied with an ink stored in an ink supply portion (not illustrated). A vibration plate 48 and piezoelectric elements 49 are disposed at the upper side (+Z-axis side) of the cavities 47, and each of the piezoelectric elements 49 is allowed to extend and contract upwardly and downwardly (in the +Z-axis direction and in the -Z-axis direction) to vibrate the vibration plate 48 so as to allow the volume of a corresponding one of the cavities 47 to be expanded and contracted.

[0041] When each of the piezoelectric elements 49 is allowed to extend and contract upwardly and downwardly to vibrate the vibration plate 48 so as to allow the volume of a corresponding one of the cavities 47 to be expanded and contracted, a corresponding one of the cavities 47 is pressurized. With this pressurization by the each of the piezoelectric elements 49, the pressure of the inside of the corresponding one of the cavities 47 varies, and as a result, the ink supplied to the inside of the corresponding one of the cavities 47 is discharged through a corresponding one of the nozzles 46. Upon receipt of a driving signal for driving one of the piezoelectric elements 49 from the controller 1, which will be described later, the discharge head 42 allows a corresponding piezoelectric element 49 to extend so as to allow the vibration plate 48 to reduce the volume of the inside of a corresponding cavity 47. As a result, an ink having an amount equivalent to the reduced volume is discharged as a liquid droplet 71 through a corresponding nozzle 46 to form a dot on the recording medium 95. In this embodiment, the discharge head 42 discharges the liquid droplets 71 each having one of mutually different sizes (i.e., large liquid droplets 71a, middle liquid droplets 71b, and small liquid droplets 71c, which will be described later).

[0042] It should be noted here that, in this embodiment, a pressurizing means using the piezoelectric element 49 of a longitudinal vibration type has been exemplified, but the piezoelectric element is not limited to this type. For example, a bending deformation type piezoelectric ele-

ment formed by stacking a lower electrode, a piezoelectric substance layer, and an upper electrode may be used. Moreover, a so-called electrostatic actuator may be employed as the pressuring means. In this electrostatic actuator, static electricity is allowed to be generated between a vibration plate and an electrode to allow an electrostatic force to deform the vibration plate so as to allow a liquid droplet to be discharged through a nozzle. Furthermore, a discharge head configured to allow a bubble to be generated inside a nozzle by means of a heat generator so as to allow the bubble to discharge an ink as a liquid droplet may be employed.

Electric Configuration

[0043] Fig. 3 is an electric block diagram illustrating an electric configuration of the printing apparatus 100. Next, the electric configuration of the printing apparatus 100 will be described referring to Fig. 3.

[0044] The printing apparatus 100 includes an image processing device 110 and the controller 1, which controls the individual components of the printing apparatus 100. A personal computer or any other information processing device may be used as the image processing device 110. The image processing device 110 (hereinafter also referred to as a PC 110) may be provided as a device independently of the printing apparatus 100.

[0045] The PC 110 includes a printer controller 111, an input section 112, a display section 113, a storage section 114, and any other component, and controls a printing job that allows the printing apparatus 100 to perform printing.

[0046] Software executed by the PC 110 includes general image processing application software (hereinafter referred to as an application) for processing image data corresponding to images to be printed, and printer driver software (hereinafter referred to as a printer driver) for generating printing data for use in the execution of printing by the controller 1.

[0047] The printer controller 111 includes a CPU (central processing unit) 115, an ASIC (application specific integrated circuit) 116, a DSP (digital signal processor) 117, a memory 118, an interface section (I/F) 119, and any other component. The interface section (I/F) 119 is a section for transmitting/receiving data transferred between the PC 110 and the controller 1.

[0048] The input section 112 is an information input means serving as a human interface. Specifically, the input section 112 corresponds to, for example, ports to which a keyboard and an information input device are coupled.

[0049] The display section 113 is an information display means (a display) serving as a human interface, and displays on itself information input from the input section 112, images to be printed by the printing apparatus 100, information in relation to a printing job, and any other information, under the control of the printer controller 111.

[0050] The storage section 114 corresponds to a HDD (hard disk drive) and a rewritable storage medium, such as a memory card, and stores in itself the software executed by the PC 110 (programs executed by the printer controller 111), the images to be printed, the information in relation to the printing job, and any other information.

[0051] The memory 118 is a storage medium for ensuring an area in which the programs executed by the CPU 115 are stored, a work area for use in the execution of the CPU 115, and any other storage area, and is constituted by memory devices, such as RAM (random access memory) devices and EEPROM (electrically erasable programmable read only memory) devices.

[0052] The controller 1 is configured to include a control circuit 4, an interface section (I/F) 2, a CPU 3, a memory 5, a driving signal generation section 6, and any other component. The interface section 2 is a section for transmitting/receiving data transferred between the controller 1 and the PC 110, which process input signals and images. The CPU 3 is an arithmetic processing device for performing various input signal processes and controlling the printing operation of the printing apparatus 100.

[0053] The memory 5 is a storage medium for ensuring an area in which programs executed by the CPU 3 are stored , a work area for use in the execution by the CPU 3, and any other storage area, and includes memory devices, such as RAM devices and EEPROM devices.

[0054] The driving signal generation section 6 generates driving signals for driving the respective piezoelectric elements 49, each of which allows an ink to be discharged as one liquid droplet 71 through a corresponding one of the nozzles 46.

[0055] The controller 1 controls the driving of each of motors disposed in the medium transport portion 20 through the use of control signals output from the control circuit 4 to move the recording medium 95 in the transport direction (in the +Y-axis direction). The controller 1 controls the driving of the motor disposed in the head moving portion 41 through the use of a control signal output from the control circuit 4 to move the carriage 43, in which the discharge head 42 is mounted, in the width direction of the recording medium 95 (i.e., in the X-axis direction). The controller 1 controls the driving of the discharge head 42 through the use of control signals output from the control circuit 4 and driving signals output from the driving signal generation section 6 to allow the inks to be discharged toward the recording medium 95. Further, the controller 1 controls individual devices that are not illustrated. The controller 1 controls the discharge operations (the discharge timing points) of the respective liquid droplets 71 on the basis of signals output from the linear encoder 91.

[0056] The controller 1 controls the head moving portion 41 and the discharge head 42 to allow the head moving portion 41 and the discharge head 42 to perform a main-scanning operation of allowing the carriage 43 (the discharge head 42) to move while allowing the inks to be discharged through the nozzles 46 of the discharge head 42, and as a result, raster lines in each of which dots

align in the main-scanning direction are formed. Further, this main-scanning operation and a sub-scanning operation of allowing the medium transport portion 20 to transport the recording medium 95 in the transport direction under the control of the controller 1 are repeatedly performed so as to allow the raster lines to be arranged in the transport direction, and as a result, images and/or the like are formed on the recording medium 95. Image Processing

[0057] Fig. 4 is a diagram illustrating image processing for printing images. Next, printing data generation processing will be described referring to Fig. 4. Upon transmission of printing data to the controller 1 from the PC 110, printing on the recording medium 95 is started. The printing data is generated by the printer driver.

[0058] Upon receipt of image data (for example, text data and/or full-color image data) from the application, the printer driver converts the received image data into printing data having a format interpretable by the controller 1, and outputs the printing data to the controller 1. When converting the image data, having been output from the application, into the printing data, the printer driver performs resolution conversion processing, color conversion processing, halftone processing, rasterization processing, command addition processing and any other processing.

[0059] The resolution conversion processing is processing for converting the image data, having been output from the application, into image data having a resolution (printing resolution) with which the printing is performed on the recording medium 95. For example, when the printing resolution is designated to 720 x 720 dpi, the resolution conversion processing converts image data having been received from the application and having a vector format into image data having a resolution of 720 x 720 dpi and having a bitmap format. Pieces of pixel data included in the image data after the resolution conversion processing are configured on the basis of pixels arranged in a matrix shape. Each of the pixels has grayscale values each being one of, for example, 256 grayscale values in an RGB color space. That is, each of the pieces of pixel data after the resolution conversion indicates grayscale values of a corresponding one of the pixels.

[0060] Pixel data corresponding to one row of pixels arranged in a predetermined direction among the pixels arranged in the matrix shape is called raster data. Here, the predetermined direction, in which pixels corresponding to the raster data are arranged, corresponds to a movement direction in which the discharge head 42 is moved when printing of images is performed (i.e., the main-scanning direction).

[0061] The color conversion processing is processing for converting RGB data into data in a CMYK color system space. The CMYK color corresponds to cyan (c), magenta (M), yellow (Y), and black (K), and image data in the CMYK color system space is data corresponding to the colors of the inks provided in the printing apparatus 100. Thus, when the printing apparatus 100 uses, for example, four kinds of inks in the CMYK color system, the printer driver generates image data in a four-dimensional CMYK color system space on the basis of the RGB data.

[0062] This color conversion processing is performed on the basis of a table (a color conversion lookup table LUT) in which each of sets of grayscale values for the RGB data is associated with a corresponding one of sets of grayscale values for the CMYK color system data. Here, the image data after the color conversion processing is, for example, 256-grayscale CMYK color system data represented by the CMYK color system space.

[0063] The halftone processing is processing for converting pieces of data each representing one of a large number of grayscale levels (256 grayscale levels) into pieces of data each representing one of at least one grayscale level whose number is formable by the controller 1. Through the halftone processing, pieces of data each representing one of the 256 grayscale levels is converted into one-bit data representing two grayscale levels (presence or absence of a dot) or two-bit data representing four grayscale levels (a dot absence, a small-size dot, a middle-size dot, and a large-size dot). Specifically, through the use of a dot generation ratio table in which each of grayscale values (0 to 255) is associated with dot generation ratios, dot generation ratios corresponding to a grayscale value (for example, in the case of the four grayscale levels, the dot absence or dot generation ratios of the respective small-size dot, middle-size dot, and large-size dot) are obtained, and pixel data is generated on the basis of the obtained generation ratios so as to allow the dots to be formed in a dispersed state through the utilization of a dither method, an error dispersion method, or any other suitable method.

[0064] That is, the pixel data after the halftone processing is composed of one-bit data or two-bit data, and each piece of pixel data constituting the pixel data becomes data indicating the formation of a dot for each pixel (i.e., the presence or absence of the dot, or the size of the dot). For example, in the case of the two-bit data (four grayscale levels), the grayscale value of the each piece of pixel data is converted into four-step values, that is, a dot grayscale value [00] corresponding to the dot absence, a dot grayscale value [01] corresponding to the small-size dot, a dot grayscale value [10] corresponding to the middle-size dot, and a dot grayscale value [11] corresponding to the large-size dot.

[0065] The rasterization processing is processing for rearranging pieces of pixel data arranged in a matrix shape (each of the pieces of pixel data being, for example, two-bit data) in accordance with dot-formation order in the execution of printing. The rasterization processing includes pass assignment processing for assigning image data composed of the pixel data after the halftone processing to each of the scanning operations, in which the discharge head 42 is allowed to discharge liquid droplets while being reciprocated. After the completion of the pass assignment, actual nozzles allowed to form each

of raster lines constituting images to be printed are assigned.

[0066] The command addition processing is processing for adding command data in accordance with a printing method to data having been substituted to the rasterization processing. A non-limiting example of the command data is transport data in relation to specifications for the transport of a medium (such as, a movement amount and a speed in a transport direction).

[0067] The printing data transmission processing is processing for transmitting the generated printing data to the controller 1 via the interface section 119.

[0068] These pieces of processing by the printer driver are executed by the ASIC 116 and the DSP 117 under the control of the CPU 115 (see Fig. 3).

Discharge Timing

[0069] Fig. 5 is a diagram illustrating the landing position of a liquid droplet that forms a middle-size dot. Fig. 6 is a diagram illustrating the landing position of a liquid droplet that forms a large-size dot. Fig. 7 is a diagram illustrating the landing position of a liquid droplet that forms a small-size dot. Here, each of Figs. 5 to 7 illustrates a discharge head 42a and a discharge head 42b on the same figure, the discharge head 42a being the discharge head 42 moving outward on the recording medium 95 along the main-scanning direction (the X-axis direction), the discharge head 42b being the discharge head 42 moving homeward on the recording medium 95 along the main-scanning direction. Next, a discharge timing point at which the liquid droplet 71 is discharged and the landing position of the liquid droplet 71 will be described.

[0070] As shown in Fig. 5, the discharge head 42a is moved (moved outward) at a constant speed in the +X-axis direction, whereas the discharge head 42b is moved (moved homeward) at the constant speed in the -X-axis direction, and each of the discharge heads 42a and 42b discharges a liquid droplet that forms a middle-size dot 72b (this liquid droplet being referred to as a middle liquid droplet 71b hereinafter) on the recording medium 95. In the X-axis direction, the middle liquid droplet 71b is discharged through one of the nozzles 46 of each of the discharge heads 42a and 42b (that is, the discharge head 42 travelling in each direction) at a discharge position distanced from a predetermined landing position A by a distance L in the direction toward the discharge position. Thus, the liquid droplet 71b lands at the same landing position A in both of the outward movement and the homeward movement. In other words, in the printing apparatus 100, the discharge timing point at which the liquid droplet 71 is to be discharged is initially set to a timing point corresponding to the distance L so as to allow the landing position of the liquid droplet 71b in the outward movement and the landing position of the liquid droplet 71b in the homeward movement to correspond to each other.

[0071] As shown in Fig. 6, each of the discharge head 42a, which moves (moves outward) at the constant speed in the +X-axis direction, and the discharge head 42b, which moves (moves homeward) at the constant speed in the -X-axis direction, discharges a liquid droplet that forms a large-size dot 72a (this liquid droplet being referred to as a large liquid droplet 71a hereinafter) on the recording medium 95. In the X-axis direction, when the large liquid droplet 71a is discharged at the same timing point as the timing point which corresponds to the distance L and at which the middle liquid droplet 71b is discharged, the large liquid droplet 71a reaches the recording medium 95 earlier than the middle liquid droplet 71b and lands at a position distanced from the predetermined landing position A by a distance M in the direction toward the discharge position because the mass of the large liquid droplet 71a is larger than that of the middle liquid droplet 71b and thus the speed reduction amount after the discharge with respect to the large liquid droplet 71a is smaller than that with respect to the middle liquid droplet 71b. That is, a discrepancy arises between the landing position in the outward movement and the landing position in the homeward movement. This landing position discrepancy is reduced by adjusting the discharge timing point so as to allow the discharge timing point to be later than the timing point corresponding to the distance L by a time period corresponding to the distance M. The distance M is also an adjustment value that is applied when the large liquid droplet 71a is discharged. The adjustment value for the large liquid droplet 71a is denoted by "-M", and is stored in the memory 118. Here, the sign "-" (minus) of the adjustment value means that the distance from the predetermined landing position A to a discharge position corresponding to a discharge timing point at which the liquid droplet 71 is discharged is made shorter than the distance L.

[0072] As shown in Fig. 7, each of the discharge head 42a, which moves (moves outward) at the constant speed in the +X-axis direction, and the discharge head 42b, which moves (moves homeward) at the constant speed in the -X-axis direction, discharges a liquid droplet that forms a small-size dot 72c (this liquid droplet being referred to as a small liquid droplet 71c hereinafter) on the recording medium 95. In the X-axis direction, when the small liquid droplet 71c is discharged at the same timing point as the timing point which corresponds to the distance L and at which the middle liquid droplet 71b is discharged, the small liquid droplet 71c reaches the recording medium 95 later than the middle liquid droplet 71b and lands at a position distanced from the predetermined landing position A by a distance P in the direction reverse to the direction toward the discharge position because the mass of the small liquid droplet 71c is smaller than that of the middle liquid droplet 71b and thus the speed reduction amount after the discharge with respect to the small liquid droplet 71c is larger than that with respect to the middle liquid droplet 71b. That is, a discrepancy arises between the landing position in the outward

movement and the landing position in the homeward movement. This landing position discrepancy is reduced by adjusting the discharge timing point so as to allow the discharge timing point to be earlier than the timing point corresponding to the distance L by a time period corresponding to the distance P. The distance P is also an adjustment value that is applied when the small liquid droplet 71c is discharged. The adjustment value for the small liquid droplet 71c is denoted by "+P", and is stored in the memory 118. Here, the sign "+" (plus) of the adjustment value means that the distance from the predetermined landing position A to a discharge point corresponding to a discharge timing point at which the liquid droplet 71 is discharged is made longer than the distance L.

Printing Method

[0073] Fig. 8 is a flowchart illustrating a printing method according to this embodiment. Fig. 9 is a diagram illustrating a method for analyzing dots, according to this embodiment. Next, the printing method according to this embodiment will be described referring to Figs. 8 and 9. Here, in this embodiment, for the sake of simplification of description, it is assumed that the discharge head 42 includes four nozzles 46, and the individual dots 72, which form images, are formed by the discharge head 42, which includes the four nozzles 46.

[0074] Step S1 is a step for receiving image data corresponding to images to be formed on the recording medium 95.

[0075] Step S2 is a step for performing image processing. The printing apparatus 100 generates pixel data 81 through the above halftone processing. In this pixel data 81, dots have been spread out by the above halftone processing (see Fig. 9).

[0076] Step S3 is a step for analyzing dots. The printer controller 111 analyses, for each of predetermined regions, the size of each of the liquid droplets 71 and quantities with respect to the liquid droplets 71 on the basis of image data corresponding to images to be printed on the recording medium 95. Here, in the printer controller 111 according to this embodiment, one raster line in which the dots 72, each formed by a corresponding one of the liquid droplets 71, align in the main-scanning direction is handled as one of the predetermined regions.

[0077] Fig. 9 illustrates an example of pixel data 81 and analysis data 82. The pixel data 81 is data in which dots have been spread out on the basis of the image data, and the analysis data 82 is data resulting from analyzing the dots. Here, at the left-hand side of the pixel data 81 in Fig. 9, the position of the discharge head 42 in the sub-scanning direction and raster-line numbers (L1 to L8) each associated with a corresponding one of raster lines each composed of a row of dots aligning in the main-scanning direction are additionally illustrated. Further, each of the raster lines L1 to L8 is associated with a corresponding one of the rows of the analysis data 82. Moreover, at the left-hand side of the discharge head 42 in Fig. 9, nozzle numbers (#1 to #4) each associated with a corresponding one of the nozzles 46 are additionally illustrated.

[0078] The dots 72 included in the raster lines L1 to L4 are formed by causing the discharge head 42 to perform a main-scanning operation in its outward movement in the +X-axis direction. The dots 72 included in the raster lines L5 to L8 are formed by causing the discharge head 42 to, after the transport of the recording medium 95 (see Fig. 1) in the transport direction (in the +Y-axis direction) by a distance corresponding to the four nozzles, perform a main-scanning operation in its homeward movement in the -X-axis direction.

[0079] In the pixel data 81, there are illustrated the large-side dots 72a, the middle-size dots 72b, and the small-size dots 72c. Through two main-scanning operations consisting of one outward movement and one homeward movement, one of the large-size dot 72a, the middle-size dot 72b, and the small-size dot 72c is formed for each of pixels corresponding to the pixel data 81. In the analysis data 82, there are illustrated, for each of the raster lines L1 to L8, the numbers of the respective large-size dots 72a, middle-size dots 72b, and small-size dots 72c, which form each of the raster lines L1 to L8. Here, in the analysis data 82, the large-size dot 72a is denoted by "L", the middle-size dot 72b is denoted by "M", and the small-size dot 72c is denoted by "S".

[0080] The printer controller 111 respectively associates the S dot, the M dot, and the L dot with a dot size value"-1", a dot size value "0", and a dot size value "+1", and calculates, for each of the raster lines L1 to L8, the average dot size value with respect to dots that form the each of the raster lines L1 to L8. The average dot size value is a value falling within a range from "-1" to "+1". For example, the raster line L2 is composed of three middle-size dots 72b and seven large-size dots 72a, and thus, the average dot size value with respect to the raster line L2 results in +0.7 (= (3 $\times$ 0 + 7 $\times$ (+1)) / 10). Further, the raster line L6 is composed of five small dots 72c and five middle dots 72b, and thus, the average dot size value with respect to the raster line L6 results in -0.5 (= (5 $\times$ (-1) + 5 $\times$ 0) / 10). This kind of average dot size value corresponds to the average liquid drop size of liquid droplets 71 forming each of the raster lines L1 to L8 among the liquid droplets 71, discharged from the individual nozzles 46. For example, the average liquid droplet size of liquid droplets discharged through the nozzle #2 during one main-scanning operation in the outward movement is "+0.7". Further, the average liquid droplet size of liquid droplets discharged through the nozzle #2 during one main scanning operation in the homeward movement is "-0.5". It should be noted here that steps S2 and S3 correspond to a step for analyzing the size of each of the liquid droplets 71 and quantities with respect to the liquid droplets 71 on the basis of image data corresponding to images to be printed on the recording medium 95.

[0081] Step S4 is a step for calculating adjustment val-

ues applied to discharge timing points at each of which a corresponding one of the liquid droplets is discharged. The printer controller 111 serves as a calculation section, and calculates adjustment values applied to discharge timing points at each of which a corresponding one of the liquid droplets 71 is discharged, on the basis of the average liquid droplet sizes having been obtained in step S3. An example of the calculation of an adjustment value for the nozzle #2 will be described below.

[0082] The average liquid droplet size for the nozzles #2 in the outward movement is "+0.7". Based on this sign "+" (plus), the printer controller 111 multiplies the adjustment value "-M" for the large liquid droplet 71a, which is stored in the memory 118, by the numerical value "0.7", and handles the resultant value "-0.7M" as the adjustment value for the nozzle #2 in the outward movement.

[0083] The average liquid droplet size for the nozzles #2 in the homeward movement is "-0.5". Based on this sign "-" (minus), the printer controller 111 multiplies the adjustment value "+P" for the small liquid droplet 71c, which is stored in the memory 118, by the numerical value "0.5", and handles the resultant value "+0.5P" as the adjustment value for the nozzle #2 in the homeward movement.

[0084] Step S5 is a step for changing the discharge timing points on the basis of the adjustment values, and executing the printing. The printer controller 111 transmits printing data involving the adjustment values applied thereto to the controller 1. Further, the controller 1 changes the discharge timing points on the basis of the adjustment values.

[0085] For example, the controller 1 changes each of the discharge timing points for the nozzle #2 from the distance L, corresponding to the discharge timing point for the middle liquid droplet 71b, into a distance "distance L - 0.7M", and executes the main-scanning operation in the outward movement. Further, the controller 1 allows the recording medium 95 to be transported in the transport direction (in the +Y-axis direction) by a distance corresponding to the four nozzles. Thereafter, the controller 1 changes each of the discharge timing points for the nozzle #2 from the distance L, corresponding to the discharge timing point for the middle liquid droplet 71b, into a distance "distance L + 0.5P", and executes the main-scanning operation in the homeward movement. Although detailed description is omitted here, with respect to each of the nozzles #1, #3, and #4, the controller 1 also changes the discharge timing points on the basis of adjustment values having been obtained in a way similar to that for the nozzle #2. The controller 1 finely corrects, for each of the nozzles 46 (for each of the raster lines), discharge timing points for the liquid droplets 71 discharged in the outward movement and discharge timing points for the liquid droplets 71 discharged in the homeward movement. This configuration, therefore, reduces the discrepancies between the landing positions in the outward movement and the landing positions in the homeward movement, and thus, reduces the degradation of printing quality due to the landing position discrepancies.

[0086] It should be noted here that, although it has been described in this embodiment that dots forming raster lines are defined as the predetermined regions, and for each of the predetermined regions (for each of the raster lines), an adjustment value is calculated and used for changing the discharge timing points, the invention is not limited to this configuration. For example, dots that are formed when the main scanning is performed once (i.e., during one pass) may be defined as one of the predetermined regions, and in the case where the image data includes a plurality of thumbnail images, dots that form each of the thumbnail images may be defined as one of the predetermined regions.

[0087] As described above, the printing apparatus 100 according to this embodiment brings about the following effects.

[0088] The printer controller 111 of the printing apparatus 100 handles the raster lines as the predetermined regions, and analyzes, for each of the predetermined regions, the size of each of liquid droplets 71 forming the each of the predetermined regions and quantities with respect to the liquid droplets 71 on the basis of image data corresponding to images to be printed on the recording medium 95 to calculate an adjustment value applied to discharge timing points at each of which a corresponding one of the liquid droplets 71, which form each of the predetermined regions, is discharged. Further, the controller 1 changes the discharge timing points on the basis of the adjustment value, and then executes the printing. With this configuration, the discrepancies between the landing positions in the outward movement and the landing positions in the homeward movement, and the degradation of printing quality due to the landing position discrepancies are reduced. Accordingly, the printing apparatus that enables the improvement of the printing quality is provided.

[0089] A printing method for the printing apparatus 100 handles raster lines as predetermined regions, and includes a step of analyzing, for each of the predetermined regions, the size of each of liquid droplets 71 forming each of the predetermined regions and quantities with respect to the liquid droplets 71 on the basis of image data corresponding to images to be printed on the recording medium 95, a step of calculating an adjustment value applied to discharge timing points at each of which a corresponding one of the liquid droplets 71, which form each of the predetermined regions, is discharged, and a step of changing the discharge timing points on the basis of the adjustment value and executing the printing. Through this method, the discrepancies between the landing positions in the outward movement and the landing positions in the homeward movement, and the degradation of printing quality due to the landing position discrepancies are reduced. Accordingly, the printing method that enables the improvement of the printing quality is provided.

[0090] The foregoing description has been given by way of example only and it will be appreciated by a person skilled in the art that modifications can be made without departing from the scope of the present invention as defined by the claims.

Claims

1. A printing apparatus (100) comprising:

a medium transport portion (20) configured to transport a recording medium (95) in a transport direction;
a discharge head (42) configured to discharge liquid droplets each having one size among mutually different sizes onto the recording medium;
a head moving portion (41) configured to reciprocate the discharge head in a main scanning direction intersecting with the transport direction;
a calculation portion configured to analyze the size of each of the liquid droplets and quantities with respect to the liquid droplets based on image data corresponding to an image to be printed on the recording medium to calculate at least one adjustment value to be applied to discharge timing points at each of which a corresponding one of the liquid droplets is discharged; and
a controller configured to change the discharge timing points based on the at least one adjustment value.

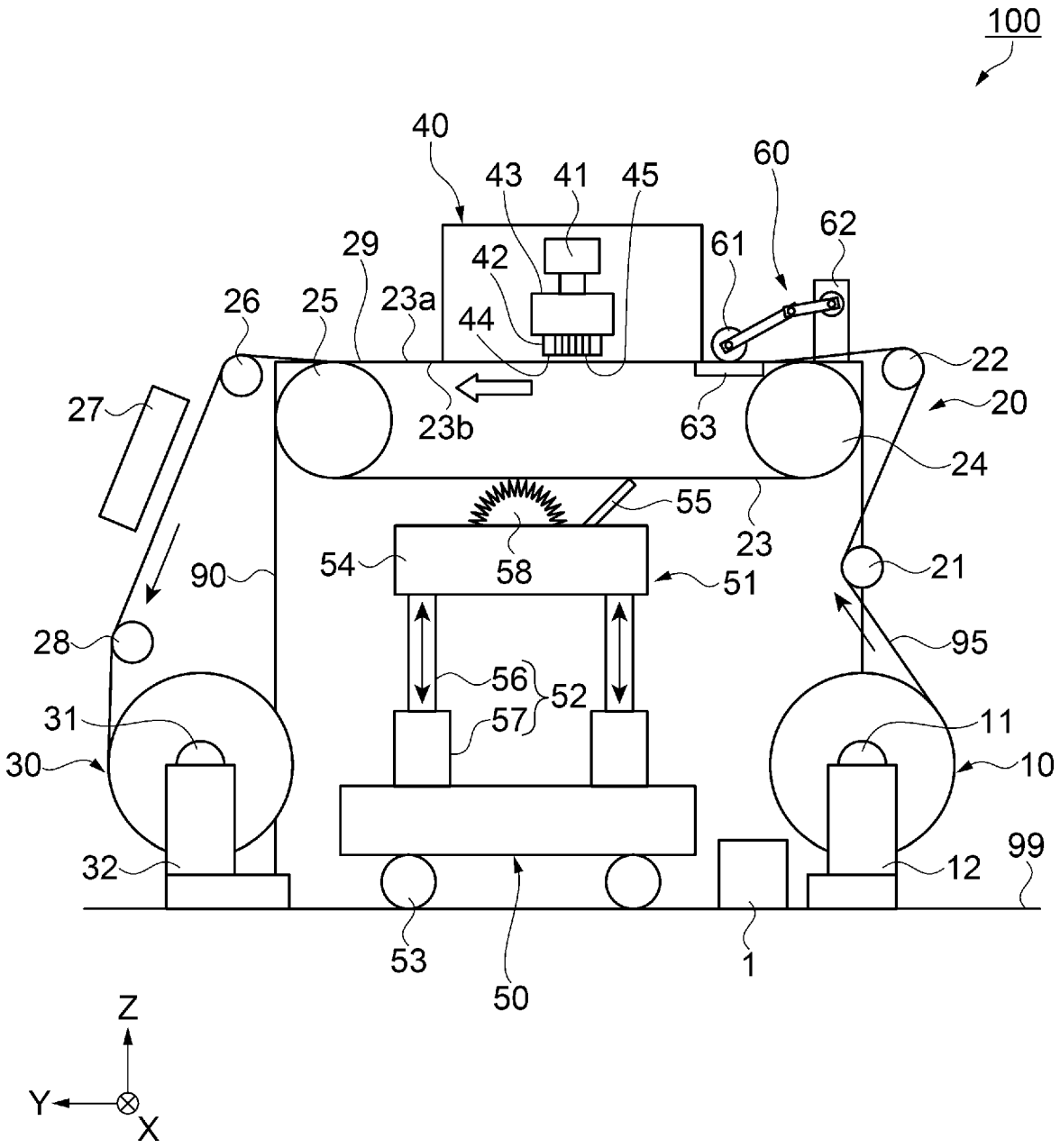
2. The printing apparatus according to claim 1, wherein the at least one adjustment value is calculated for each of at least one predetermined region, and the discharge timing points are changed for each of the at least one predetermined region.

3. The printing apparatus according to claim 2, wherein each of the at least one predetermined region corresponds to a set of one or more raster lines in each of which dots formed by liquid droplets among the liquid droplets align in the main scanning direction.

4. A printing method for a printing apparatus (100) including a medium transport portion (20) configured to transport a recording medium (95) in a transport direction, a discharge head (42) configured to discharge liquid droplets each having one size among mutually different sizes onto the recording medium, and a head moving portion (41) configured to reciprocate the discharge head in a main scanning direction intersecting with the transport direction, the printing method comprising:

analyzing the size of each of the liquid droplets and quantities with respect to the liquid droplets based on image data corresponding to an image to be printed on the recording medium;
calculating at least one adjustment value to be applied to discharge timing points at each of which a corresponding one of the liquid droplets is discharged; and
changing the discharge timing points based on the at least one adjustment value.

FIG. 1


100
40
43
41
45
60
62
29
42
61
26
25
23a
44
22
27
23b
63
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55
23
54
58
51
90
21
28
95
56
52
31
57
11
30
10
32
12
99
53
50
1
Z
Y
X

FIG. 2

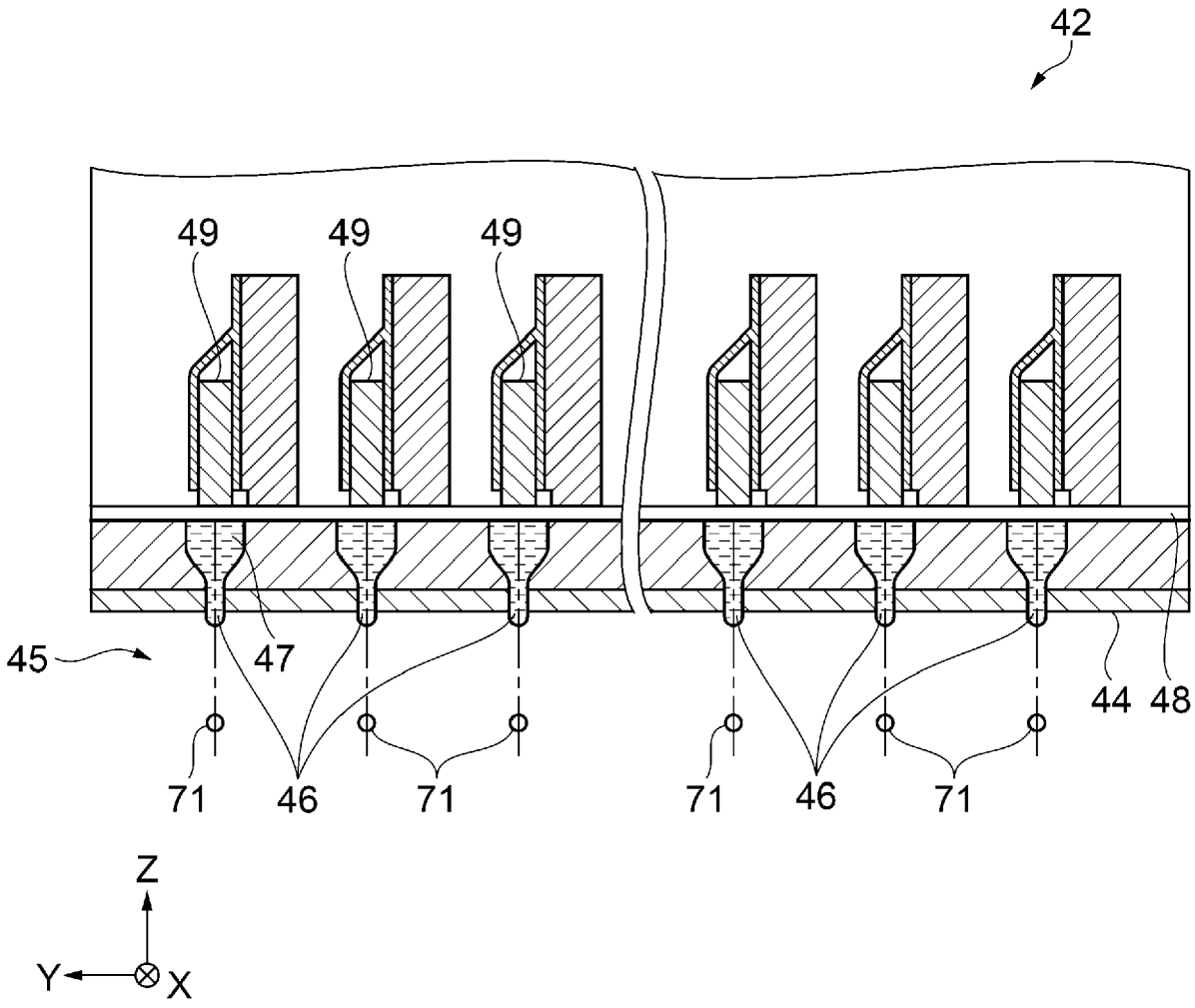


FIG. 3

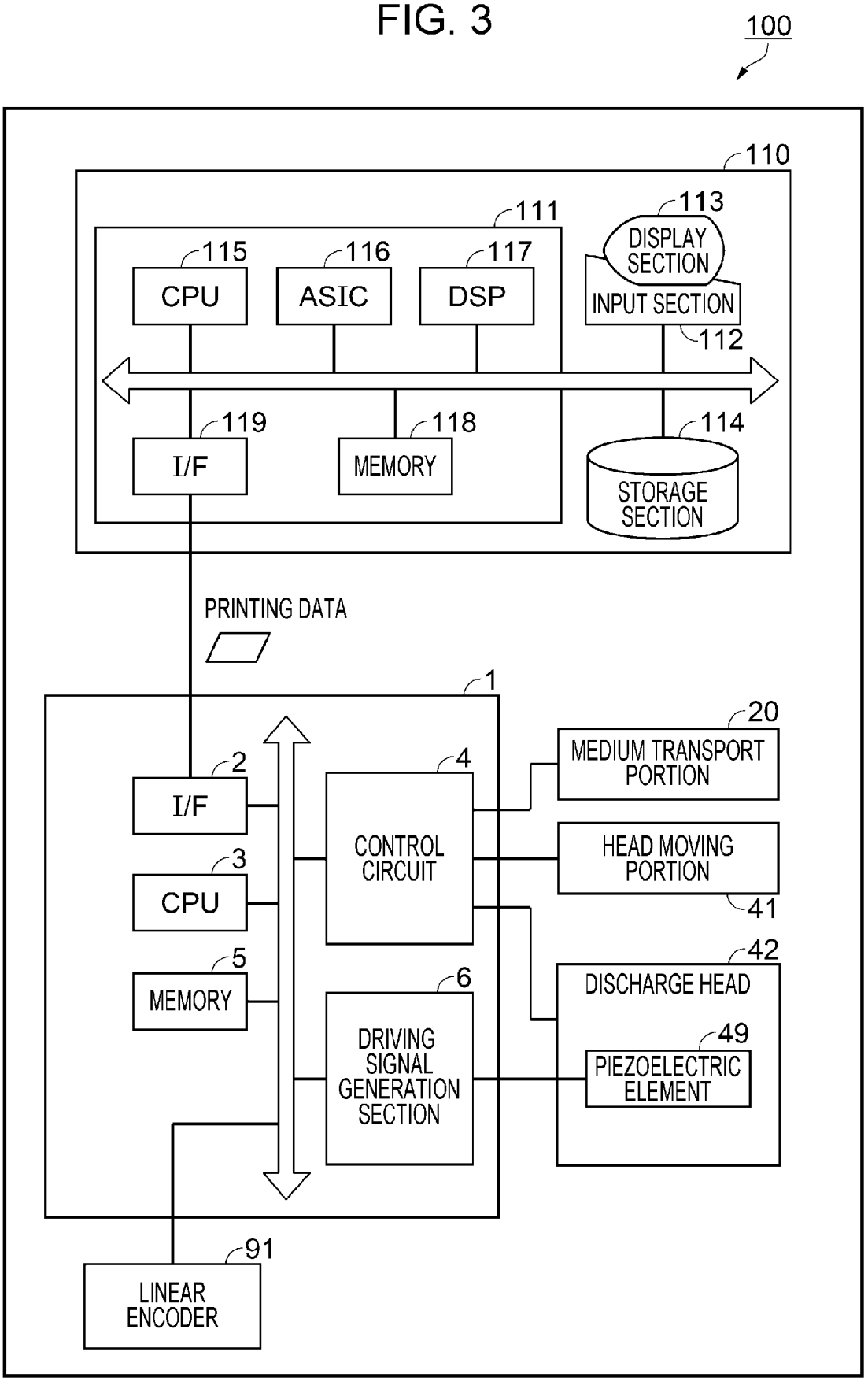

100
110
111
113
DISPLAY SECTION
115
116
117
CPU
ASIC
DSP
INPUT SECTION
112
119
118
114
I/F
MEMORY
STORAGE SECTION
PRINTING DATA
1
20
2
4
MEDIUM TRANSPORT PORTION
I/F
CONTROL CIRCUIT
3
HEAD MOVING PORTION
CPU
41
42
5
6
DISCHARGE HEAD
MEMORY
DRIVING SIGNAL GENERATION SECTION
49
PIEZOELECTRIC ELEMENT
91
LINEAR ENCODER

FIG. 4

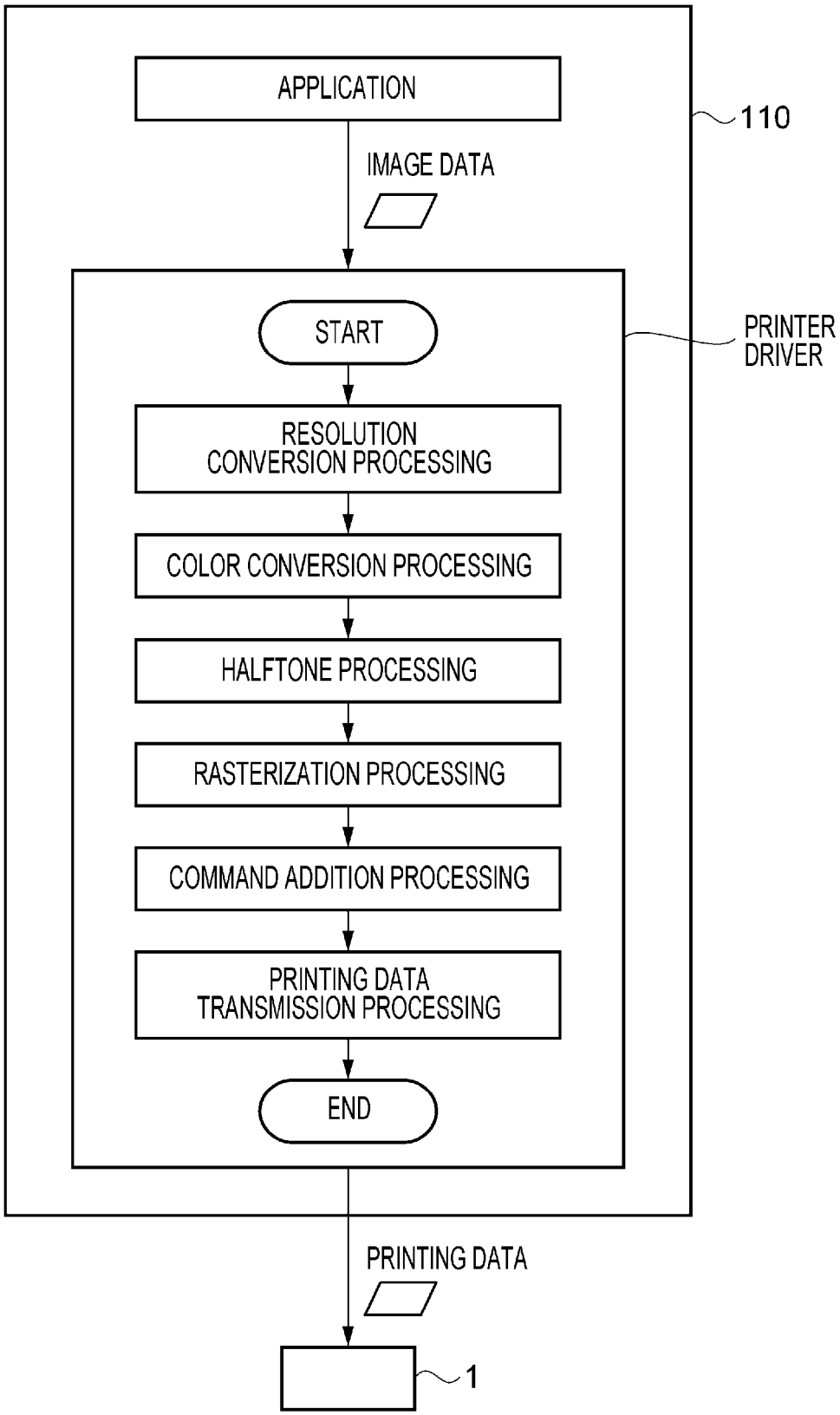

APPLICATION
110
IMAGE DATA
START
PRINTER DRIVER
RESOLUTION CONVERSION PROCESSING
COLOR CONVERSION PROCESSING
HALFTONE PROCESSING
RASTERIZATION PROCESSING
COMMAND ADDITION PROCESSING
PRINTING DATA TRANSMISSION PROCESSING
END
PRINTING DATA
1

FIG. 5

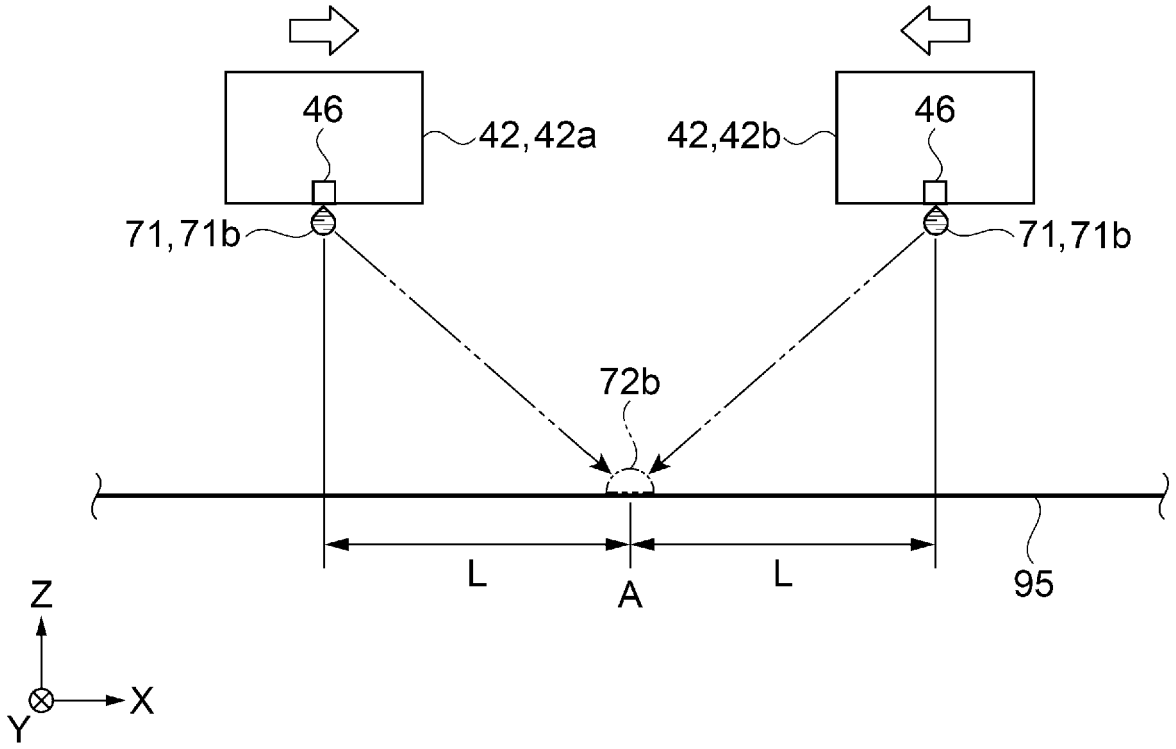

46
42,42a
42,42b
46
71,71b
71,71b
72b
L
A
L
95
Z
X
Y

FIG. 6

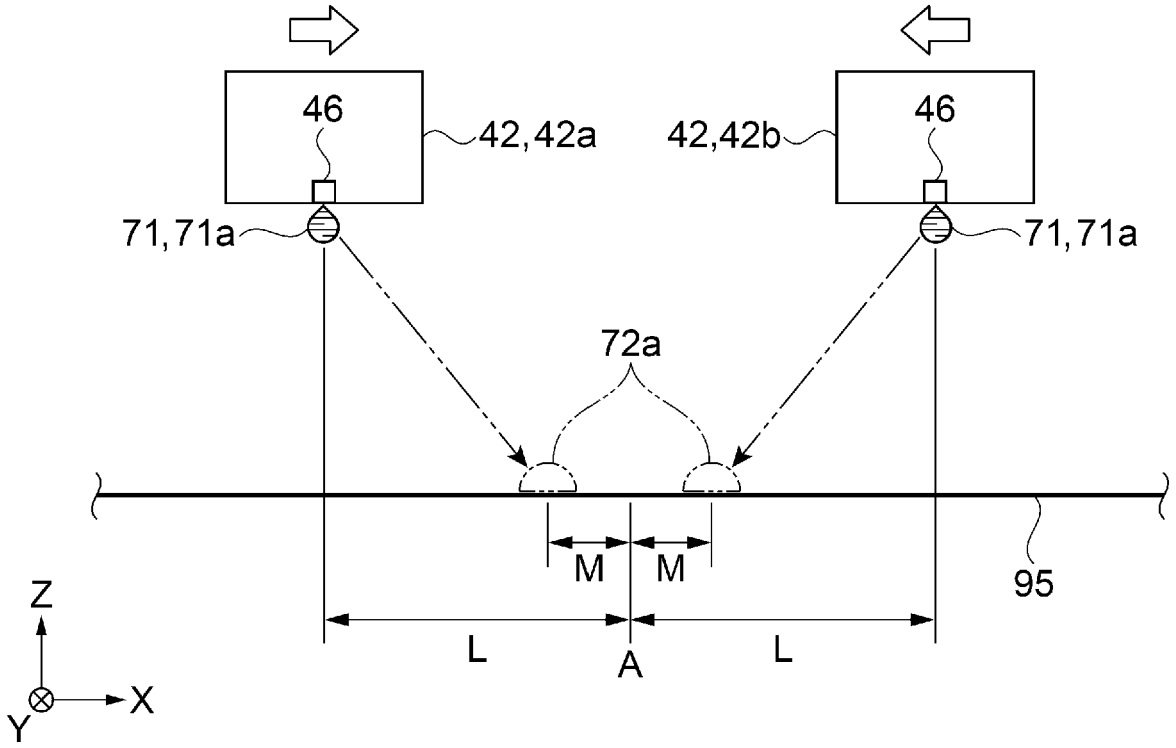

46
42,42a
42,42b
46
71,71a
71,71a
72a
M
M
95
L
A
L
Z
X
Y

FIG. 7

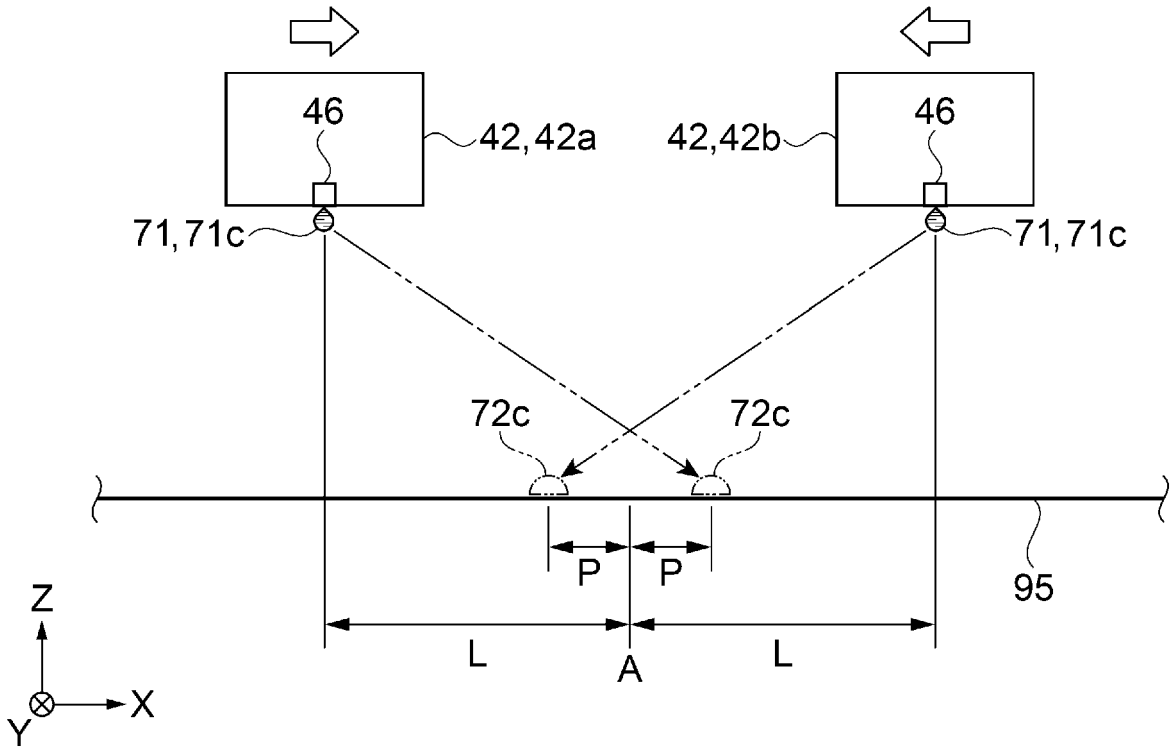


FIG. 8

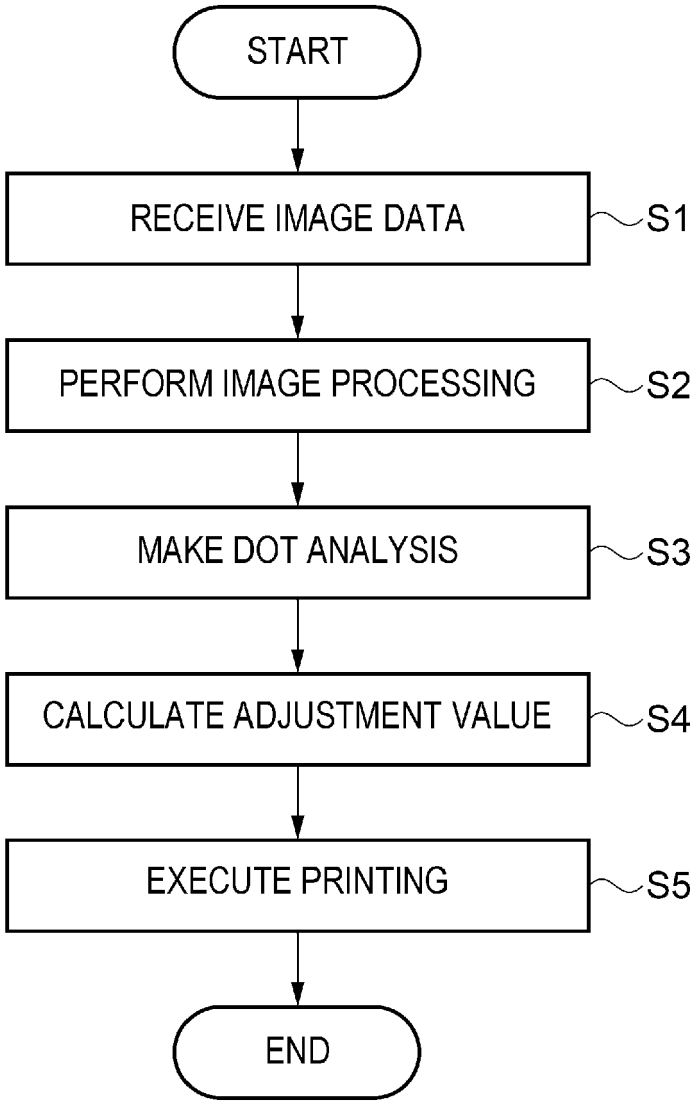
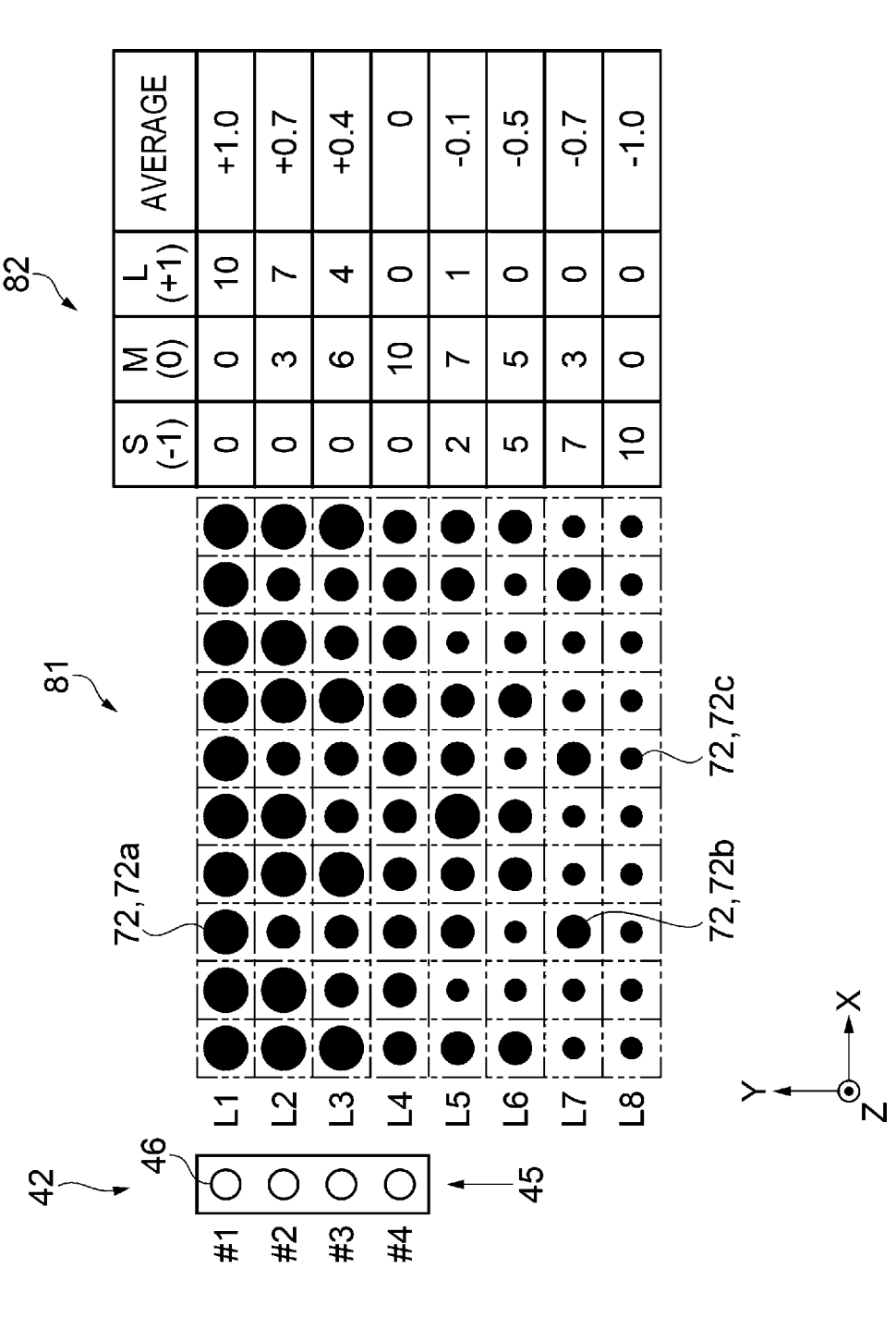

START
RECEIVE IMAGE DATA
S1
PERFORM IMAGE PROCESSING
S2
MAKE DOT ANALYSIS
S3
CALCULATE ADJUSTMENT VALUE
S4
EXECUTE PRINTING
S5
END

FIG. 9



	S (-1)	M (0)	L (+1)	AVERAGE
L1	0	0	10	+1.0
L2	0	3	7	+0.7
L3	0	6	4	+0.4
L4	0	10	0	0
L5	2	7	1	-0.1
L6	5	5	0	-0.5
L7	7	3	0	-0.7
L8	10	0	0	-1.0

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EUROPEAN SEARCH REPORT

Application Number
EP 17 16 7548

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/251503 A1 (KASHIMOTO YUSUKE [JP]) 8 October 2009 (2009-10-08) * paragraph [0014] - paragraph [0019] * * paragraph [0043] - paragraph [0053]; claims 1-14; figures 1-10 *	1-4	INV. B41J2/21 B41J19/14
A	JP 2002 011869 A (SEIKO EPSON CORP) 15 January 2002 (2002-01-15) * abstract; figures 1-22 *	1-4	
A	US 2013/278661 A1 (TERADA KOHEI [JP]) 24 October 2013 (2013-10-24) * paragraph [0082] - paragraph [0100]; claim 1; figures 1-12 *	1-4	
			TECHNICAL FIELDS SEARCHED (IPC)
			B41J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 September 2017	Janosch, Joachim

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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L : document cited for other reasons

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