PRINTING APPARATUS AND PRINTING METHOD

BACKGROUND

1. Technical Field

**[0001]**@001 The present invention relates to a printing apparatus and a printing method.

2. Related Art

**[0002]**@002 A printing apparatus which performs printing on a recording medium using ink has been used (for example, JP-A-2010-5827). A printing apparatus described in JP-A-2010-5827 includes a transport unit which transports a recording medium, and a printing unit which includes multiple nozzles that eject ink on a recording medium which is being transported, while reciprocating in a direction intersecting a transport direction of the recording medium.

**[0003]**@003 The printing apparatus has a possibility that significant deviation of a position where ink is landed on a forward path and a backward path of the printing unit occurs according to a distance between the recording medium and the printing unit, or a material of the recording medium, and quality of an image which is obtained is degraded. Accordingly, it is considered that ejection position change correction is performed in which ink that is ejected into the other path is ejected into one path such that the ink is ejected only into one path of a forward path and a backward path of a printing unit.

**[0004]**@004 However, the printing apparatus described in JP-A-2010-5827 has a possibility that inks of a portion where ejection position change correction is performed overlaps, in a case where the ejection position change correction is performed. In this case, an area where inks overlap has a different hue from an area where inks do not overlap, at a portion the ejection position change correction is performed. As a result, quality of an obtained image may be degraded.

SUMMARY

**[0005]**@006 An advantage of some aspects of the invention is to provide a printing apparatus and a printing method which can prevent an obtained image from being degraded.

**[0006]**@007 The advantage is achieved by the following aspect of the invention.

**[0007]**@007 According to one aspect of the invention, there is provided a printing apparatus including: a printing unit that forms a first printing area in a recording medium which is transported by ejecting first ink onto a first path in a direction crossing a transport direction of the recording medium, and thereafter, forms a second printing area in the recording medium by ejecting second ink onto a second path different from the first path, and thereby forms an image which is configured with the first printing area and the second printing area; a decision unit that decides a first ejection position of the first ink in the first path and decides a second ejection position of the second ink in the second path, when the image is formed; and a correction determination unit that performs ejection position change correction in which the first ejection position is changed such that the first ink is ejected onto the second path and the second ejection position is changed such that a part of the second ink is ejected onto the first path.

**[0008]**@008 Thereby, for example, it is possible to prevent inks in which ejection position change correction is performed from overlapping each other. Hence, it is possible to prevent image quality from being degraded due to overlapping of the inks in which the ejection position change correction is performed.

**[0009]**@009 In the printing apparatus of the aspect of the invention, the printing unit may form an overlapping portion in which the first printing area and the second printing area partially overlap each other in a plan view of the recording medium.

**[0010]**@010 Thereby, it is possible to prevent the degradation of image quality from occurring in an image, in a case where ejection position change correction is performed.

**[0011]**@011 In the printing apparatus of the aspect of the invention, the second ink which is ejected onto the first printing area may be shifted from the first ink which is ejected onto the second printing area in a plan view of the recording medium, when being ejected, in the ejection position change correction.

**[0012]**@012 Thereby, degradation of image quality which occurs in an image in a case where ejection position change correction is performed can be more effectively prevented or suppressed.

**[0013]**@013 In the printing apparatus of the aspect of the invention, in a case where the printing unit forms the image by moving n number of times (n is an integer greater than or equal to two), the correction determination unit may divide the second printing area into n areas and determine whether to perform the ejection position change correction for each of the divided areas or not.

**[0014]**@014 Thereby, degradation of image quality which occurs in an image in a case where ejection position change correction is performed can be more effectively prevented or suppressed.

**[0015]**@015 In the printing apparatus of the aspect of the invention, the second ink which is ejected onto the first printing area may be ejected onto the overlapping portion, in the ejection position change correction.

**[0016]**@016 Thereby, it is possible to prevent inks in which ejection position change correction is performed from overlapping each other.

**[0017]**@017 In the printing apparatus of the aspect of the invention, the second ink which is ejected onto the first printing area may be ejected into a position different from the overlapping portion, in the ejection position change correction.

**[0018]**@018 Thereby, it is possible to prevent inks in which ejection position change correction is performed from overlapping each other.

**[0019]**@019 In the printing apparatus of the aspect of the invention, the printing unit may eject at least two types of ink whose hues are different from each other, and the correction determination unit may perform the ejection position change correction for ink with a smaller amount of ejection per unit area in the image among the two types of ink.

**[0020]**@020 Thereby, it is possible to prevent inks in which ejection position change correction is performed from overlapping each other.

**[0021]**@021 According to another aspect of the invention, there is provided a printing method including: forming a first printing area in a recording medium which is transported by ejecting first ink onto a first path in a direction crossing a transport direction of the recording medium, and thereafter, forming a second printing area in the recording medium by ejecting second ink onto a second path different from the first path, and thereby forming an image which is configured with the first printing area and the second printing area; deciding a first ejection position of the first ink in the first path and deciding a second ejection position of the second ink in the second path, when the image is formed; and performing ejection position change correction in which the first ejection position is changed such that the first ink is ejected onto the second path and the second ejection position is changed such that a part of the second ink is ejected onto the first path.

**[0022]**@022 Thereby, for example, it is possible to prevent inks in which ejection position change correction is performs from overlapping each other. Hence, it is possible to prevent image quality from being degraded due to overlapping of the inks in which the ejection position change correction is performed.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0023]** The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

**[0024]**@023 Fig. 1 is a side view schematically illustrating a first embodiment of a printing apparatus according to the invention.

**[0025]** Fig. 2 is a block diagram of the printing apparatus illustrated in Fig. 1.

**[0026]** Fig. 3 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 prints an image.

**[0027]** Fig. 4 is a diagram illustrating a process in which the printing apparatus of the related art performs ejection position change correction and prints an image.

**[0028]** Fig. 5 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 performs the ejection position change correction and prints an image.

**[0029]** Fig. 6 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 performs the ejection position change correction and prints an image.

**[0030]**  Fig. 7 is a flowchart illustrating a control operation of a control unit which is included in the printing apparatus illustrated in Fig. 1.

**[0031]** Fig. 8 is a diagram illustrating a process in which a printing apparatus (second embodiment) of the invention performs the ejection position change correction and prints an image.

**[0032]** Fig. 9 is a diagram illustrating a process in which a printing apparatus (third embodiment) of the invention performs the ejection position change correction and prints an image.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

**[0033]**@024 Hereinafter, a printing apparatus and a printing method according to the invention will be described in detail, based on a preferred embodiment illustrated in the accompanying drawings.

First Embodiment

**[0034]**@025 Fig. 1 is a side view schematically illustrating a first embodiment of a printing apparatus according to the invention. Fig. 2 is a block diagram of the printing apparatus illustrated in Fig. 1. Fig. 3 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 prints an image. Fig. 4 is a diagram illustrating a process in which the printing apparatus of the related art performs ejection position change correction and prints an image. Fig. 5 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 performs the ejection position change correction and prints an image. Fig. 6 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 performs the ejection position change correction and prints an image. Fig. 7 is a flowchart illustrating a control operation of a control unit which is included in the printing apparatus illustrated in Fig. 1.

**[0035]**@026 Hereinafter, three axes of an x-axis, a y-axis, and a z-axis which are orthogonal to each other are illustrated in Fig. 1, and Fig. 3 to Fig. 6 for the sake of convenient description. The x-axis is formed in one direction (width (depth in the figure) of the printing apparatus) of a horizontal direction, and the y-axis is formed in a direction (longitudinal direction of the printing apparatus) perpendicular to the x-axis in the horizontal direction, and the z-axis is formed in a vertical direction (up and down direction). In addition, a front end side of each arrow which is illustrated is referred to as a “positive side (+ side)”, and a base end side thereof is referred to as a “negative side (- side)”. An upper side of Fig. 1, and Fig. 3 to Fig. 6 is referred to as “top (top side)”, and a lower side thereof is referred to as “bottom (bottom side)”.

**[0036]**@027 As illustrated in Fig. 1 and Fig. 2, a printing apparatus 1 executes a printing method of the invention, and includes a machine base 11, a transport mechanism unit (transport unit) 12 which transports a workpiece W as a recording medium, a printing mechanism unit (printing unit) 13 which performs printing by providing ink 100 on the workpiece W, a drying unit 2 which dries the ink 100 on the workpiece W, and an elevation mechanism 14.

**[0037]**@028 In the present embodiment, a direction orthogonal to a transport direction in which the workpiece W is transported is referred to as an x-axis direction, a direction parallel with the transport direction is referred to as a y-axis direction, and a direction orthogonal to the x-axis direction and the y-axis direction is referred to as a z-axis direction.

**[0038]**@029 The transport mechanism unit 12 includes a delivering device 3 which delivers the long workpiece W which is wound in a roll shape, a winding device 4 which winds the printed workpiece W, and a supporting device 5 which is provided on the machine base 11 and supports the workpiece W during printing.

**[0039]**@030 The delivering device 3 is disposed further on an upstream side than the machine base 11 in a sending direction (y-axis direction) of the workpiece W. The delivering device 3 includes a sending roller (delivery reel) 31 to which the workpiece W is wound in a roll shape and which sends the workpiece W, and a tensioner 32 which applies tension to the workpiece W between the sending roller 31 and the supporting device 5. The sending roller 31 is connected to a motor (not illustrated), and can be rotated by an operation of the motor.

**[0040]**@031 In addition, a material to be printed can be used as the workpiece W. The material to be printed includes textile which is printed, clothing, other clothing products, or the like. The textile includes fabric, knitted fabric, non-woven fabric, or the like of such as a natural fiber such as cotton, silk, or wool, a chemical fiber such as nylon, or a composite fiber to which the natural fiber and the chemical fiber are mixed. In addition, clothing or other apparel products also include textile or the like before or after being cut, which exist as a part of a state before being sewed, in addition to furniture of such as a T-shirt, a handkerchief, a scarf, a towel, a carrier-bag, a clothing bag, a curtain, a sheet, or a bed cover which are sewed.

**[0041]**@032 In addition to the aforementioned material to be printed, normal paper, fine paper, special paper for ink jet recording such as glossy paper, or the like can be used as the workpiece W. In addition, for example, a plastic film for ink jet printing in which surface treatment is not made (that is, an ink absorbing layer is not formed), a material, which is coated with plastic, such as paper, or a material to which a plastic film is attached can also be used as the workpiece W. The plastic is not limited in particular, and for example, polyvinyl chloride, polyethylene terephthalate, polycarbonate, polystyrene, polyurethane, polyethylene, and polypropylene can be used as the plastic.

**[0042]**@033 The winding device 4 is disposed further on a downstream side than the machine base 11 in the sending direction (y-axis direction) of the workpiece W with respect to the delivering device 3. The winding device 4 includes a winding roller (winding reel) 41 which winds the workpiece W in a roll shape, and tensioners 42, 43, and 44 which apply tension to the workpiece W between the winding roller 41 and the supporting device 5. The winding roller 41 is connected to a motor (not illustrated), and can be rotated by an operation of the motor. The tensioners 42 to 44 are arranged with a gap between each other in an ascending order being drifted from the winding roller 41.

**[0043]**@034 The supporting device 5 is disposed between the delivering device 3 and the winding device 4. The supporting device 5 includes a main driving roller 51 a follower roller 52 which are separately disposed in the y-axis direction, an endless belt 53 which is stretched over the main driving roller 51 and the follower roller 52 and supports the workpiece W over an upper surface (supporting surface), tensioners 54 and 55 which applies tension to the workpiece W between the main driving roller 51 and the follower roller 52.

**[0044]**@035 The main driving roller 51 is connected to a motor (not illustrated), and can be rotated by an operation of the motor. In addition, the follower roller 52 receives a rotating force of the main driving roller 51 through the endless belt 53, and can rotate in conjunction with the main driving roller 51,

**[0045]**@036 The endless belt 53 has a front surface on which ah adhesive layer with adhesiveness. A part of the workpiece W is adhesively fixed to the adhesive layer, and the workpiece W is transported in the y-axis direction. In addition, while the workpiece is transported, the workpiece W is printed. In addition, after being printed, the workpiece W is peeled from the endless belt 53.

**[0046]**@037 The tensioners 54 and 55 are also disposed with a gap between each other in the y-axis direction in the same manner as the main driving roller 51 and the follower roller 52.

**[0047]**@038 The workpiece W can be interposed between the tensioner 54 and the main driving roller 51 for each endless belt 53, and the workpiece W can be interposed between the tensioner 55 and the follower roller 52 for each endless belt 53. Thereby, the workpiece W to which tension is applied by the tensioners 54 and 55 is fixed to the endless belt 53 to be transported in a state where the tension is applied. By doing so, the workpiece W is prevented, for example, from being wrinkled during transport, and thus, in a case of printing, the printing can be performed accurately and with high quality.

**[0048]**@039 The printing mechanism unit 13 includes a carriage unit 132 including multiple ink jet heads 131 which perform recording by ejecting the ink 100 onto the workpiece W for printing, and an X-axis table (not illustrated) which movably supports the carriage unit 132 in the x-axis direction. Each of the ink jet heads 131 includes a head body which is filled with the ink 100 and in which a head inner flow path is formed, and multiple nozzle groups 6 which respectively have openings.

**[0049]**@040 The head body includes piezoelectric elements (piezoelectric members) respectively corresponding to ejection nozzles, and if pressure is applied to the piezoelectric elements, the ink 100 is ejected from the nozzle group 6 as droplets.

**[0050]**@041 The ink jet heads 131 stands by at a position (standby position) far apart from the workpiece W (endless belt 53) when viewing from the z-axis direction, in a state where the ink 100 is not ejected.

**[0051]**@042 In the printing apparatus 1, the workpiece W which is delivered by the delivering device 3 is intermittently sent (performs subscan) in the y-axis direction in a state of being adhesively fixed to the endless belt 53, and the ink 100 is ejected from the nozzle group 6 toward the workpiece W which is adhesively fixed, while the carriage unit 132 reciprocates (performs main scan) in the x-axis direction. This operation can be performed until printing is completed and an image pattern is formed on the workpiece W. The image pattern may be formed by multicolor printing (color printing), and may be formed by single color printing.

**[0052]**@043 The ink 100 has four colors of, for example, cyan (C), magenta (M), yellow (Y), and black (K), which are obtained by mixing dye or pigment that is a colorant into water that is a solvent. In addition, various types of the ink 100 are independently ejected from the ink jet heads 131.

**[0053]**@044 The elevation mechanism 14 illustrated in Fig. 1 and Fig. 2 can adjust a height of the nozzle group 6. The elevation mechanism 14 can be configured to include, for example, a motor, a ball screw, and a linear guide. In addition, an encoder can be embedded in the motor. A height of the ink jet head 131 can be detected based on the amount of rotation which is detected by the encoder. The elevation mechanism 14 is also electrically connected to a control unit 15.

**[0054]**@045 As such, a distance between the nozzle group 6 and the workpiece W can be adjusted by the elevation mechanism 14. Hence, it is possible to perform good printing in accordance with a material of the workpiece W.

**[0055]**@046 As illustrated in Fig. 1, the drying unit 2 is disposed between the supporting device 5 and the winding roller 41 of the winding device 4, further on a downstream side than the printing mechanism unit 13 in the transport direction of the workpiece W.

**[0056]**@047 The drying unit 2 includes a chamber 21 and a coil 22 which is disposed within the chamber 21. The coil 22 is, for example, a light emitting unit which is configured by a nichrome wire and emits light by receiving electric power. In addition, the ink 100 on the workpiece W which passes through the chamber 21 can be dried by heat that is generated by the coil 22.

**[0057]**@048 As illustrated in Fig. 2, the control unit 15 is electrically connected to the drying unit 2, the transport mechanism unit 12, the printing mechanism unit 13, and the elevation mechanism 14, and has a function of controlling operations thereof. In addition, the control unit 15 includes a central processing unit (CPU) 151 and a storage unit 155.

**[0058]**@049 The CPU 151 executes a program for various types of processing such as the aforementioned printing. In addition, the CPU 151 functions as a path analysis unit (decision unit) 152, a correction determination unit 153, and an execution unit 154.

**[0059]**@050 The path analysis unit 152 performs analysis of deciding a position where the ink 100 is ejected into a forward path and a backward path, based on image data which is input.

**[0060]**@051 The correction determination unit 153 performs path shifting (will be described below) in data which is obtained by performing path analysis using the path analysis unit 152. The execution unit 154 performs printing, based on the data which is obtained by performing path analysis using the correction determination unit 153.

**[0061]**@052 The storage unit 155 includes, for example, an electrically erasable programmable read only memory (EEPROM) which is a type of a nonvolatile semiconductor memory, or the like, and can store various programs or the like.

**[0062]**@053 In the printing apparatus 1, the ink 100 is ejected while reciprocating is performed n number of times (n is a positive integer of two or larger) and thereby an image is formed by as illustrated in Fig. 3. Hereinafter, detailed description thereof will be made, and a forward path of a first time is referred to as a first path (path of n = 1), and a backward path of a first time is referred to as a second path (path of n = 2). In addition, a forward path of a second time is referred to as a third path (path of n = 3), and a backward path of a second time is referred to as a fourth path (path of n = 4) (in the same manner, a positive integer is replaced with n also in the forward path of a third time or later). In addition, a printing area A1 which is printed in a first path and a printing area A2 which is printed in a second path have the same length L in the transport direction of the workpiece W (also the same as at a printing area A3 or later).

**[0063]**@054 In the printing apparatus 1, first, the printing area A1 is formed by ejecting the ink 100 onto an area, which is denoted by hatching, of the workpiece W in Fig. 3 during a first path. Subsequently, the printing area A2 is formed by shifting further on an upstream side than the printing area A1 in the transport direction. At this time, the amount of the printing area A2 which is shifted is 1/4 of a length L of the printing area A1. That is, the printing area A1 and the printing area A2 overlap each other by 3/4 of the length L and are shifted by 1/4 of the length L. In the printing apparatus 1, printing areas A3, A4, A5, and A6 are formed in the same manner as this.

**[0064]**@055 Hereinafter, a case where an image with dot density (density of droplets) of yellow (Y) of 100% and black (K) of 12% is printed will be described as an example. In addition, in this case, for example, yellow of 100% and black of 12% are uniformly divided into four paths to be printed, and a ratio between yellow (Y) and black (K) is 25:3 in each path. Hereinafter, ink with the ratio is referred to as “ink 100C”.

**[0065]**@056 Although the same ink is used, spreading of the ink in case where printing is performed on the unprinted workpiece W is different from spreading of the ink in a case where printing is performed on the printed workpiece W. Accordingly, color of the formed printing area is made by printing the area at a portion which is not printed until then, but color is changed whether or not the color is made by printing an unprinted portion.

**[0066]**@057 Hereinafter, a color of an area made by printing on the unprinted workpiece W using ink 100C with a ratio between yellow (Y) and black (K) of 25:3 is referred to as a color a, and a color of an area made by printing on the workpiece which is previously printed in the ink 100 using the ink 100C with a ratio between yellow (Y) and black (K) of 25:3 is referred to as a color b.

**[0067]**@058 In the printing apparatus 1, when printing of the first path is completed, the entire printing area A1 is printed with the color a. When printing of the second path is completed, a 1/4 area on a downstream side of the printing area A1 is maintained to be the color a. In addition, an area where the printing area A1 and the printing area A2 overlap each other is maintained to be a color a+b. In addition, 1/4 area on an upstream side of the printing area A2 has the color a. “+” indicates overlap of colors.

**[0068]**@059 When printing of the third path is completed, a color of 1/4 area on the downstream side is the color a, and a color of an area where the printing area A1 and the printing area A2 overlap each other is the color a+b, in the printing area A1. In addition, an area where the printing area A1, the printing area A2, and the printing area A3 overlap each other has a color a+b+b (color a+2b). In addition, an area where the printing area A2 and the printing area A3 overlap each other has the color a+b. In addition, an area in which only the printing area A3 is printed has the color a.

**[0069]**@060 If printing is performed in the same manner, when printing of the fourth path is completed, areas of the color a, the color a+b, the color a+2b, a color a+3b, a color a+2b, the color a+b, and the color a are sequentially lined up from a downstream side. When printing of a fifth path is completed, areas of the color a, the color a+b, the color a+2b, the color a+3b, the color a+3b, the color a+2b, the color a+b, and the color a are sequentially lined up from the downstream side. When printing of a sixth path is completed, areas of the color a, the color a+b, the color a+2b, the color a+3b, the color a+3b, the color a+3b, the color a+2b, the color a+b, and the color a are sequentially lined up from the downstream side.

**[0070]**@061 In the printing apparatus 1, the area in which a color of the ink 100 is the color a+3b becomes an actual product, and the areas of the color a, the color a+b, and the color a+2b are discarded. As such, in the printing apparatus 1, a portion which becomes a product by the printing of the fourth path is obtained, and a portion of an area which becomes a product by the fifth path or later increases.

**[0071]**@062 In a general printing apparatus, in a case where ink is ejected toward an arbitrary position, deviation occurs at a landing position of the ink in a forward path and a backward path. This is because orientations of inertial forces acting on the ink in the forward path and the backward path are different from each other. Particularly, if a magnitude of ink droplets is relatively small or a distance between a nozzle and a recording medium is relatively short, significant deviation easily occurs at the landing position of the ink in the forward path and the backward path. In a case where the deviation occurs, “path shifting” which will be described hereinafter is considered as means for reducing the deviation.

**[0072]**@063 Hereinafter, an example of the path shifting of the printing apparatus 1 will be described. Hereinafter, a case where the path shifting is performed to the ink 100 of black (K) among the inks 100 of yellow (Y) and the black (K) will be described.

**[0073]**@064 In the printing apparatus 1, the ink 100 of black (K) which is ejected into the first path, the third path, and the fourth in the first to fourth path paths is ejected into the second path. That is, ejection position change correction (path shifting) in which ejection position is changed is performed.

**[0074]**@065 By performing the ejection position change correction, a ratio, which is 25:3 before being corrected, between yellow (Y) and black (K) in each path becomes a ratio of 25:0 between yellow (Y) and black (K) in the first path. The ratio between yellow (Y) and black (K) in the second path becomes 25:12. The ratio between yellow (Y) and black (K) in the third path becomes 25:0. The ratio between yellow (Y) and black (K) in the fourth path becomes 25:0. Thereby, ejecting the ink 100 of black (K) into the first path, the third path, and the fourth path can be omitted. In the same manner as also in the fifth path to the eighth path, the ink 100 of black (K) which is ejected into the fifth path, the seventh path, and the eighth path is ejected into the sixth path (also the same as in a ninth path or later).

**[0075]**@066 An image which is obtained when printing is performed by performing the path shifting will be described with reference to Fig. 4. Hereinafter, a color appearing in a case where the ink 100 in which a ratio between yellow (Y) and black (K) is 25:0 is landed on the workpiece W on which the ink 100 is not landed yet is regarded as a color a (hereinafter, ink in which the ratio between yellow (Y) and black (K) is 25:0 is referred to as ink 100A). In addition, a color appearing in a case where the ink 100A is landed so as to overlap another ink 100 is regarded as a color b. In addition, a color appearing in a case where the ink 100 in which the ratio between yellow (Y) and black (K) is 25:12 is landed on the workpiece W on which the ink 100 is not landed yet is referred to as a color c (hereinafter, ink in which the ratio between yellow (Y) and black (K) is 25:12 is referred to as ink 100B). In addition, a color appearing in a case where the ink 100B is landed so as to overlap another ink 100 is referred to as a color d.

**[0076]**@067 In a case where printing is performed in the same manner as the aforementioned printing method, when printing in the first path is completed, an area of the color a is formed. When printing in the second path is completed, areas of the color a, the color a+d, and the color c are sequentially formed in parallel from a downstream side in an ascending order. When printing in the third path is completed, areas of the color a, the color a+d, the color a+b+d, the color b+c, the color b+c, and the color a are sequentially formed in parallel from a downstream side in an ascending order. When printing in the fourth path is completed, areas of the color a, the color a+d, the color a+b+d, the color a+2b+d, the color 2b+c, the color a+b, and the color a are sequentially formed in parallel from a downstream side in an ascending order. When printing in the fifth path is completed, areas of the color a, the color a+d, the color a+b+d, the color a+2b+d, the color 3b+c, the color a+2b, the color a+b, and the color a are sequentially formed in parallel from a downstream side in an ascending order. When printing in the sixth path is completed, areas of the color a, the color a+d, the color a+b+d, the color a+2b+d, the color 3b+c, the color a+2b+d, the color a+b+d, the color a+d, and the color c are sequentially formed in parallel from a downstream side in an ascending order.

**[0077]**@068 An image which is formed by performing the path shifting has a portion in which areas of the color a+2b+d and the color 3b+c become actual products, remaining portion are discarded. In addition, by performing the path shifting, printing in three paths of the four paths can be omitted, and thus, deviation of the landing position of the ink 100 in the forward path and the backward path can be reduced as described above. Furthermore, the ink 100 which is omitted by the path shifting is allocated to other paths, and thus, a total amount of ejection of the ink 100 becomes equal and degradation of image quality can be less likely to occur in view of the entire image.

**[0078]**@069 However, although the path shifting is performed, if a color difference between the area of the color a+2b+d and the area of the color 3b+c is relatively large, streak unevenness occurs at a portion which actually becomes a product and image quality is degraded. There is a possibility that significant degradation of image quality occurs when a difference between the color a and the color b and a difference between the color c and the color d are large.

**[0079]**@070 The printing apparatus 1 can prevent image quality from being degraded due to the path shifting. Hereinafter, this will be described.

**[0080]**@071 As described in Fig. 5, when the path shifting is performed in the printing apparatus 1, the ink 100A in which a ratio between the yellow (Y) and black (K) is 25:0 is ejected onto the entire printing area A1.

**[0081]**@072 In addition, when the printing area A2 is divided into four areas in the transport direction, the ink 100B in which a ratio between yellow (Y) and black (K) is 25:12 is ejected onto 3/4 area A21 from a downstream side. In addition, the ink 100A is ejected onto 1/4 area A22 from an upper area of the printing area A2.

**[0082]**@073 In addition, when the set area A3 is divided into four areas in the transport direction, the ink 100A is ejected onto 1/2 area A31 from a downstream side. In addition, the ink 100B is ejected onto 1/4 area A32 on an upstream side of the area A31. In addition, the ink 100A is ejected onto 1/4 area A33 on an upstream side of the area A32.

**[0083]**@074 The ink 100A in which a ratio between yellow (Y) and black (K) is 25:0 is ejected onto the entire printing area A4.

**[0084]**@075 By performing the path shifting, a portion onto which the ink 100B is directly landed in the workpiece W can be omitted. The ink 100B which is ejected onto the printing area A2 and the printing area A3 is landed so as to overlap the ink 100A. That is, the ink 100B is ejected onto an overlapping portion in which the printing area A1 to A4 overlap each other. Accordingly, it is possible to prevent the color c from appearing when the ink 100B is directly landed onto the workpiece W, as illustrated in Fig. 6. Hence, a color of a portion which actually becomes a product is only the color a+2b+d, regardless of the path shifting which is performed. Thus, it is possible to prevent image quality from being degraded due to a color difference between the color a+2b+d and 3b+c which is caused by path shifting of the related art. As a result, in the printing apparatus 1, although the path shifting is performed, an image with high printing accuracy can be formed. Areas onto which the ink 100B is ejected is denoted by cross-hatching in Fig. 6.

**[0085]**@076 Next, a control operation of the control unit 15 will be described by using a flowchart illustrated in Fig. 7.

**[0086]**@076 In step S101, path analysis is performed based on image data which is input to the printing apparatus 1. The amount of ink 100 which will be ejected onto the path is determined.

**[0087]**@077 Subsequently, in step S102, it is determined whether or not the path shifting will be performed based on a work cap or the like. In a case where it is determined that there is a possibility that image quality is degraded if the path shifting is not performed in step S102, the following path shifting processing is performed in step S103.

**[0088]**@078 As illustrated in Fig. 5, the printing area A1 to A4 are respectively divided into four areas along the transport direction. In addition, it is determined whether or not the path shifting is performed for each divided area, that is, it is determined which of the ink 100A and the ink 100B will be ejected.

**[0089]**@079 It is determined that the ink 100B is ejected onto the 3/4 area A21 from a downstream side among the divided four areas of the printing area A2. In addition, it is determined that the ink 100A is ejected onto the area A31 and the area A33 in the area A3, and it is determined that the ink 100B is ejected onto the area A32. In addition, it is determined that the ink 100A is ejected onto the entire areas of the printing area A1 and the printing area A4.

**[0090]**@080 As such, the printing area A1 to the printing area A4 are respectively divided, the ink 100A or the ink 100B is allocated to each divided area, and thereby, portions where the path shifting is performed in an image which is formed, that is, the inks 100B can be prevented from being landed so as to overlap each other. Hence, it is possible to prevent image quality of an image which is obtained from being degraded.

**[0091]**@081 The ink 100A and the ink 100B are also allocated in the fifth path or later in the same manner as in the first path to fourth path.

**[0092]**@082 Subsequently, in step S104, printing is performed according to the setting which is determined in step S103. Thereby, it is possible to form an image in which the path shifting is performed.

**[0093]**@083 In a case where it is determined that the pat shifting is not performed in step S102, printing is performed in a state where the path analysis is performed in step S101 without the path shifting.

**[0094]**@084 As described above, when focusing on the printing area A2 and the printing area A3, according to the path shifting of the related art, by changing an ejection position such that the ink 100 which is ejected onto the printing area A3 is ejected onto the printing area A2, only the ink 100A that is the first ink is ejected onto the printing area A3, and only the ink 100B that is the second ink is ejected onto the printing area A2. In contrast to this, in the invention, when the path shifting is performed, not only an ejection position (first ejection position) of the ink 100 which is ejected onto the printing area A3 is changed to the printing area A2, but also an ejection position (second ejection position) of a part of the ink 100B (second ink) which is ejected onto the printing area A2 is changed to the printing area A3. Thereby, it is possible to prevent image quality from being degraded due to the path shifting which is performed. As the result, although the path shifting is performed, an image with high printing accuracy can be formed.

**[0095]**@085 The path shifting can be performed by selecting whether or not each of the multiple nozzles included in the nozzle group ejects the ink 100.

**[0096]**@086 In addition, in the present embodiment, the printing apparatus 1 provides setting in which an image is formed by using four paths such as the first path to the four path or the fifth path to the eighth path as one set, but the invention is not limited to this. For example, an image may be formed by setting two paths, three paths, five paths or more as one set. In addition, during the path shifting at this time, when the number of paths of one set is n, each path is divided into n areas in a transport direction, and the ink 100A and the ink 100B are allocated to each of the divided areas.

Second Embodiment

**[0097]**@087 Fig. 8 is a diagram illustrating a process in which a printing apparatus (second embodiment) of the invention performs the ejection position change correction and prints an image.

**[0098]**@088 Hereinafter, a second embodiment of a printing apparatus according to the invention will be described with reference to the figure, but points different from the aforementioned embodiment will be mainly described, and description on the same points will be omitted.

**[0099]**@088 The present embodiment is the same as the first embodiment except for control when ejection position change correction is performed.

**[0100]**@089 As illustrated in Fig. 8, in the present embodiment, the ink 100A and the ink 100B are allocated as follows when the path shifting is performed.

**[0101]**@090 The ink 100A is ejected onto the entire printing area A1. In addition, when the printing area A2 is divided into four areas in a transport direction, the ink 100B is ejected onto a 1/2 area A23 from a downstream side. The ink 100A is ejected onto a 1/2 area A24 on an upstream side of the area A23 of the printing area A2. In addition, the ink 100A is ejected onto the entire printing area A3. In addition, when the printing area A4 is divided into four areas in the transport direction, the ink 100B is ejected onto a 1/2 area A41 from a downstream side. The ink 100A is ejected onto a 1/2 area A42 on an upstream side of the area A41 of the printing area A4.

**[0102]**@091 According to the present embodiment, a portion where the ink 100B is directly landed on the workpiece W can be omitted in the same manner as in the first embodiment. Hence, it is possible to prevent image quality from being degraded due to a hue difference between the color a+2b+d and the color 3b+c which is caused by the path shifting of the related art. Furthermore, when viewing from the entire image, it is possible to further reduce a boundary of an area on which the ink 100B is landed. As the result, a portion where streak unevenness easily occurs is reduced in an image which is obtained. As described above, in the present embodiment, although the path shifting is performed, an image with high printing accuracy can be formed.

Third Embodiment

**[0103]**@092 Fig. 9 is a diagram illustrating a process in which a printing apparatus (third embodiment) of the invention performs the ejection position change correction and prints an image.

**[0104]**@093 Hereinafter, a third embodiment of a printing apparatus according to the invention will be described with reference to the figure, but points different from the aforementioned embodiment will be mainly described, and description on the same points will be omitted.

**[0105]**@094 The present embodiment is the same as the first embodiment except for control when ejection position change correction is performed.

**[0106]**@095 As illustrated in Fig. 9, in the present embodiment, the ink 100A and the ink 100B are allocated as follows when the path shifting is performed.

**[0107]**@096 The ink 100B is ejected onto the entire printing area A1.

**[0108]**@096 In addition, when the printing area A2 is divided into four areas in a transport direction, the ink 100A is ejected onto a 3/4 area A21 from a downstream side. The ink 100B is ejected onto a 1/4 area A22 on an upstream side of the area A21 of the printing area A2.

**[0109]**@097 In addition, when the printing area A3 is divided into four areas in the transport direction, the ink 100A is ejected onto a 1/2 area A31 from a downstream side. The ink 100A is ejected onto a 1/4 area A32 on an upstream side of the area A31 of the printing area A3. The ink 100B is ejected onto a 1/4 area A33 on an upstream side of the area A31 of the printing area A3.

**[0110]**@098 In addition, when the printing area A4 is divided into four areas in the transport direction, the ink 100A is ejected onto a 3/4 area A41 from a downstream side. The ink 100B is ejected onto a 1/4 area A42 on an upstream side of the area A41 of the printing area A4.

**[0111]**@099 According to the present embodiment, it is possible to prevent the ink 100B from being landed so as to overlap the ink 100A and the ink 100B. That is, in the present embodiment, the ink 100B is ejected onto areas which are different from overlapping portions where the printing area A1 to A4 overlap each other in a plan view of the workpiece W. Thereby, it is possible to omit a color d which is generated by landing the ink 100B so as to overlap the ink 100A and the ink 100B. Hence, in the workpiece W, a color of a portion which is actually used as a product becomes a color 3b + a color c. Thus, it is possible to prevent image quality from being degraded due to a hue difference between the color a+2b+d and the color 3b+c which is caused by the path shifting of the related art. Furthermore, an order of the ink 100A and the ink 100B which overlap each other is also the same, in each of the printing areas and thus, it is possible to form an image with higher printing accuracy.

**[0112]**@100 As described above, embodiments of a printing apparatus and a printing method according to the invention are described, but the invention is not limited to this, and each unit configuring the printing apparatus can be replaced with elements having an arbitrary configuration that can perform the same function. In addition, an arbitrary configuration element may be added thereto.

**[0113]**@101 In addition, the printing apparatus according to the invention may be configured by combining arbitrary two or more configurations (characteristics) of the respective embodiments.

**[0114]**@102 In addition, in each embodiment, a case where the printing mechanism unit ejects ink as droplets with the same size is described, but the invention is not limited to this, and the ink may be ejected as droplets with sizes of two type or more. In this case, the ejection position change correction described above may be performed for each ink of droplets with each size.

What is claimed is:

1. A printing apparatus comprising:

a printing unit that forms a first printing area in a recording medium which is transported by ejecting first ink onto a first path in a direction crossing a transport direction of the recording medium, forms a second printing area in the recording medium by ejecting second ink onto a second path different from the first path, and thereby forms an image which is configured with the first printing area and the second printing area;

a decision unit that decides a first ejection position of the first ink in the first path and a second ejection position of the second ink in the second path, when the image is formed; and

a correction determination unit that performs ejection position change correction in which the first ejection position is changed such that the first ink is ejected onto the second path and the second ejection position is changed such that a part of the second ink is ejected onto the first path, based on decision results of the decision unit.

2. The printing apparatus according to Claim 1, wherein the printing unit forms an overlapping portion in which the first printing area and the second printing area partially overlap each other in a plan view of the recording medium.

3. The printing apparatus according to Claim 2, wherein the second ink which is ejected onto the first printing area is shifted from the first ink which is ejected onto the second printing area in a plan view of the recording medium, when being ejected, in the ejection position change correction.

4. The printing apparatus according to Claim 2, wherein, in a case where the printing unit forms the image by moving n number of times (n is an integer greater than or equal to two), the correction determination unit divides the second printing area into n areas and determines whether to perform the ejection position change correction for each of the divided areas or not.

5. The printing apparatus according to Claim 2, wherein the second ink which is ejected onto the first printing area is ejected onto the overlapping portion, in the ejection position change correction.

6. The printing apparatus according to Claim 2, wherein the second ink which is ejected onto the first printing area is ejected into a position different from the overlapping portion, in the ejection position change correction.

7. The printing apparatus according to Claim 1,

wherein the printing unit ejects at least two types of ink whose hues are different from each other, and

wherein the correction determination unit performs the ejection position change correction for ink with a smaller amount of ejection per unit area in the image among the two types of ink.

8. A printing method of performing printing by using a printing apparatus including a printing unit that forms a first printing area in a recording medium which is transported by ejecting first ink onto a first path in a direction crossing a transport direction of the recording medium, forms a second printing area at a position different from the first printing area by ejecting second ink onto a second path different from the first path, and thereby forms an image which is configured with the first printing area and the second printing area, and a decision unit that decides a first ejection position of the first ink in the first path and a second ejection position of the second ink in the second path, when the image is formed, the method comprising:

performing ejection position change correction in which the first ejection position is changed such that the first ink is ejected onto the second path and the second ejection position is changed such that a part of the second ink is ejected onto the first path.

ABSTRACT

A printing mechanism unit that forms a first printing area in a recording medium which is transported by ejecting first ink onto a first path in a direction crossing a transport direction of the recording medium, forms a second printing area in the recording medium by ejecting second ink onto a second path different from the first path, and thereby forms an image which is configured with the first printing area and the second printing area; a path analysis unit that decides a first ejection position of the first ink in the first path and decides a second ejection position of the second ink in the second path, when the image is formed; and a correction determination unit that performs ejection position change correction in which the first ejection position is changed such that the first ink is ejected onto the second path and the second ejection position is changed such that a part of the second ink is ejected onto the first path, are provided.