United States Patent	12393149
Kind Code	B2
Date of Patent	August 19, 2025
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Image forming apparatus that corrects image forming positions

Abstract

An image forming apparatus is configured to, based on a reading result of a test image, generate data that is used to adjust image forming positions of toner images to be formed by an image forming unit, control an image forming position of a first toner image to be formed by the image forming unit in a first contact state based on first data, the first toner image being transferred to a first sheet, and control an image forming position of a second toner image to be formed by the image forming unit in a second contact state based on second data that is different from the first data, the second toner image being transferred to a second sheet, wherein a type of the second sheet is the same type as the type of the first sheet.

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Appl. No.: **18/757205**

Filed: **June 27, 2024**

Prior Publication Data

Document Identifier	Publication Date
US 20240345524 A1	Oct. 17, 2024

Foreign Application Priority Data

JP	2022-083992	May. 23, 2022

Related U.S. Application Data

continuation parent-doc US 18319304 20230517 US 12050426 child-doc US 18757205

Publication Classification

Int. Cl.: **G03G15/00** (20060101); **G03G15/01** (20060101); **G06K15/00** (20060101); **G06K15/02** (20060101)

U.S. Cl.:

CPC **G03G15/5062** (20130101); **G03G15/0136** (20130101); **G03G15/0178** (20130101); **G03G15/0189** (20130101); G03G15/5041 (20130101); G03G2215/0193 (20130101); G06K15/002 (20130101); G06K15/027 (20130101)

Field of Classification Search

CPC: G03G (15/0136); G03G (15/0178); G03G (15/0189); G03G (15/5062); G03G (15/5041); G03G (2215/0193); G06K (15/002); G06K (15/027)

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Background/Summary

CROSS REFERENCE OF RELATED APPLICATIONS (1) This application is a continuation of U.S. patent application Ser. No. 18/319,304, filed May 17, 2023, which claims the benefit of Japanese Patent Application No. 2022-083992, filed May 23, 2022, all of which are hereby incorporated by reference herein in its entirety.

BACKGROUND
Field of the Disclosure
(1) The present disclosure relates to an image forming apparatus that corrects image forming positions.
Description of the Related Art
(2) Print products generated by an image forming apparatus, such as a commercial printer, are required to have high accuracy in terms of image forming positions on a front surface and a back surface. It is suggested in Japanese Patent Laid-Open No. 2006-11285 that a reference chart be printed, and correction values for front and back image forming positions be determined in accordance with a reading result of the reference chart.
(3) Meanwhile, in a tandem image forming apparatus that forms full-color images, abrasion occurs

due to contact between four photosensitive drums and a transfer belt. It is suggested in Japanese Patent Laid-Open No. 11-167238 that three photosensitive drums other than a photosensitive drum for black be separated from a transfer belt in a monochrome mode.
(4) In an image forming apparatus in which the state of contact between four photosensitive drums and a transfer belt varies between a color mode and a monochrome mode, an image forming position on a front surface differs from an image forming position on a back surface during double-sided printing. When three photosensitive drums other than a photosensitive drum for black are separated from the transfer belt, the tension of the transfer belt decreases, and it takes more time for a toner image to arrive at a transfer roller. On the other hand, when the four photosensitive drums come in touch with the transfer belt, the tension of the transfer belt increases, and it takes less time for a toner image to arrive at the transfer roller. Therefore, if correction values for image forming positions for a color mode are generated using a chart printed in a monochrome mode, an error may occur. Likewise, if correction values for image forming positions for monochrome are generated using a chart printed in a color mode, an error may occur.
SUMMARY
(5) The present disclosure provides an image forming apparatus comprising an image forming unit including a plurality of color image forming units and a black image forming unit, the plurality of color image forming units including a plurality of photosensitive members on which color toner images of different colors are respectively formed, the black image forming unit including a photosensitive member on which a black toner image is formed, an intermediate transfer member to which the color toner images and the black toner image are transferred, a transfer unit that transfers the color toner images and the black toner image from the intermediate transfer member to a sheet, a mechanical mechanism that controls a contact state between the plurality of photosensitive members of the plurality of color image forming units and the intermediate transfer member and between the photosensitive member of the black image forming unit and the intermediate transfer member, the contact state including: a first contact state in which the photosensitive member of the black image forming unit is in contact with the intermediate transfer member and the plurality of photosensitive members of the plurality of color image forming units are separated from the intermediate transfer member; and a second contact state in which the plurality of photosensitive members of the plurality of color image forming units and the photosensitive member of the black image forming unit are in contact with the intermediate transfer member, a fixing unit that fixes the color toner images and the black toner image on the sheet, a reading unit that reads a test image on a sheet formed by the image forming unit, and a controller configured to, based on a reading result of the test image by the reading unit, generate data that is used to adjust image forming positions of toner images to be formed by the image forming unit, control an image forming position of a first toner image to be formed by the image forming unit in the first contact state based on first data, the first toner image being transferred to a first sheet, and control an image forming position of a second toner image to be formed by the image forming unit in the second contact state based on second data that is different from the first data, the second toner image being transferred to a second sheet, wherein a type of the second sheet is a same type as a type of the first sheet.
(6) Further features of the present disclosure will become apparent from the following description of embodiments (with reference to the attached drawings).

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a diagram for describing an image forming system.
(2) FIG. **2** is a diagram for describing an image forming apparatus.

(3) FIG. **3**A is a diagram for describing an in-touch state of a transfer belt.
(4) FIG. **3**B is a diagram for describing a separated state of the transfer belt.
(5) FIG. **4** is a diagram for describing CIS units.
(6) FIG. **5** is a diagram for describing test patterns.
(7) FIGS. **6**A and **6**B are diagrams for describing a measurement method.
(8) FIG. **7** is a block diagram showing an internal controller of a printing apparatus.
(9) FIG. **8** is a block diagram showing an internal controller of a finisher.
(10) FIGS. **9**A to **9**D are a diagram for describing setting screens.
(11) FIG. **10** is a flowchart showing a method of generating correction values.
(12) FIG. **11** is a diagram for describing a database.
(13) FIG. **12** is a flowchart showing an image forming method, including processing for selecting correction values.

DESCRIPTION OF THE EMBODIMENTS

(14) Hereinafter, embodiments will be described in detail with reference to the attached drawings. Note, the following embodiments are not intended to limit the scope of the claimed disclosure. Multiple features are described in the embodiments, but limitation is not made to a disclosure that requires all such features, and multiple such features may be combined as appropriate. Furthermore, in the attached drawings, the same reference numerals are given to the same or similar configurations, and redundant description thereof is omitted.

(15) (Image Forming System)

(16) FIG. **1** shows an image forming system **100**. The image forming system **100** includes an image forming apparatus **101** and an external controller **102**. The image forming apparatus **101** and the external controller **102** are connected via an internal LAN **105** and a video cable **106** in a communication-enabled manner. LAN is an acronym for a local area network. The external controller **102** is connected to a client PC **103** via an external LAN **104** in a communication-enabled manner, and accepts print instructions from the client PC **103**. PC is an acronym for a personal computer.

(17) The client PC **103** includes a printer driver. The printer driver converts print data into a print description language that can be processed by the external controller **102**. A user generates print data using various types of applications, and issues a print instruction via the printer driver. Based on the print instruction from the user, the printer driver transmits the print data to the external controller **102**.

(18) Upon receiving the print instruction from the client PC **103**, the external controller **102** performs data analysis and rasterizing processing. The external controller **102** inputs the print data to the image forming apparatus **101**, and issues a print instruction thereto.

(19) The image forming apparatus **101** is configured in such a manner that a plurality of apparatuses with different functions are connected thereto, and it can perform complex print processing, such as bookbinding. In the present example, the image forming apparatus **101** includes a printing apparatus **107** and a finisher **109**.

(20) The printing apparatus **107** forms images on sheets that are conveyed from a feeding unit located on a lower side of the printing apparatus **107**, and outputs the sheets to the finisher. The finisher **109** is a postprocessing apparatus on which the sheets can be loaded. The finisher **109** may include a postprocessing unit that executes postprocessing, such as aligning, punching, and stapling of a stack of sheets.

(21) Although the external controller **102** is connected to the image forming apparatus **101** in FIG. **1**, this is merely an example. That is to say, the image forming apparatus **101** may be connected to the external LAN **104**, and receive print data that can be processed by the image forming apparatus **101** from the client PC **103**. In this case, the image forming apparatus **101** executes data analysis and rasterizing processing. That is to say, the image forming apparatus **101** may include the functions of the external controller **102**.

(22) (Image Forming Apparatus)

(23) FIG. **2** shows main components of the image forming apparatus **101**. The printing apparatus **107** includes feeding decks **201***a* and **201***b*. Hereinafter, lower-case alphabets appended at the ends of reference signs are used to distinguish between the same or similar constituent elements. In describing matters that are common to a plurality of constituent elements, lower-case alphabets may be omitted from reference signs.

(24) The feeding decks **201***a* and **201***b* can each store a large number of sheets. The feeding decks **201***a* and **201***b* feed one sheet that is located at the top of the plurality of sheets to a conveyance path R**1**. The conveyance path R**1** includes a plurality of conveyance roller pairs **202** that convey the sheet. Similarly to the conveyance roller pairs **202**, the sets of two circles adjoined to each other shown in FIG. **2** each represent a conveyance roller pair.

(25) Development stations **203***a* to **203***d* form toner images using toner colored in Y (yellow), M (magenta), C (cyan), and K (black), respectively, and transfer the toner images to a transfer belt **204**. The transfer belt **204** rotates, thereby conveying the toner images to a secondary transfer unit **205**. The secondary transfer unit **205** transfers the toner images to the sheet. The secondary transfer unit **205** is configured to perform the conveyance while holding the transfer belt **204** and the sheet between two rollers.

(26) An operation unit **225** includes a display apparatus (e.g., a liquid crystal panel) that displays a printing status of the image forming apparatus **101** and information for settings. Furthermore, the operation unit **225** includes input apparatuses (e.g., a touch sensor and keys) that accept user instructions.

(27) Fixing devices **206***a* and **206***b* fix the toner images on the sheet. The fixing devices **206***a* and **206***b* include a pressurizing roller **217** and a heating roller **218**. The sheet passes between the pressurizing roller **217** and the heating roller **218**; as a result, the toner is fused, and the toner is bonded to the sheet by pressure. After passing through the fixing device **206***a*, the sheet is conveyed to a conveyance path R**4** via a conveyance path R**2**. Depending on the type of the sheet, further fusing and pressure-bonding may be necessary for the purpose of fixing. In this case, the sheet that has passed through the fixing device **206***a* is conveyed to the fixing device **206***b* via a conveyance path R**3**, additional fusing and pressure-bonding are applied thereto, and then the sheet is conveyed to the conveyance path R**4**.

(28) In a case where a print mode is double-sided printing, the sheet with an image formed on a first surface thereof is conveyed to a conveyance path R**5**, and then the traveling direction of the sheet is inverted. The sheet is sent from the conveyance path R**5** to a conveyance path R**6**, and further conveyed from the conveyance path R**6** back to the conveyance path R**1**. The secondary transfer unit **205** transfers the toner images to a second surface of the sheet, the second surface being opposite to the first surface of the sheet.

(29) The conveyance path R**4** includes CIS units **207***a* and **207***b*. The CIS unit **207***a* reads the image on the first surface of the sheet. The CIS unit **207***b* reads the image on the second surface of the sheet. CIS is an acronym for a contact image sensor. The CIS units **207***a* and **207***b* are situated downstream relative to the fixing devices **206***a* and **206***b* in a conveyance direction in which the sheet is conveyed. The term “downstream” or “downstream side” in a direction of sheet conveyance refers to the forward side as seen along the direction of flow and travel. In other words, if the seat is going in the forward direction, it is going downstream. The upstream is opposite of the downstream.

(30) A flapper **208** guides the sheet to a conveyance path R**7** or a conveyance path R**8**. The conveyance path R**7** conveys the sheet to the finisher **109**. The conveyance path R**8** conveys the sheet to a discharge tray **210**. Sheets discharged to the discharge tray **210** include a sheet on which a test image has been formed, a sheet that has remained inside the printing apparatus **107** at the time of the occurrence of a jam, and so forth. Discharging the remaining sheet to the discharge tray **210** alleviates a load placed on the user in taking care of the jam.

(31) The finisher **109** in the present example includes a stack tray **211** on which large volumes of sheets can be loaded. Sheets conveyed from the printing apparatus **107** are loaded on the stack tray **211** via a conveyance path R**9**. The finisher **109** detects normal passing of sheets using sheet sensors **212***a* to **212***d*. In a case where normal passing of sheets has not been detected, the finisher **109** determines that a conveyance jam has occurred, and notifies the printing apparatus **107** of the occurrence of the conveyance jam. As a result, remaining sheets that have been conveyed inside the printing apparatus **107** are discharged to the discharge tray **210**.
(32) (Touch and Separation Mechanism)
(33) A development station **203** includes a charging device that charges a photosensitive drum **301**, an exposure device that generates an electrostatic latent image by exposing the photosensitive drum **301** to light, a development device that forms a toner image by developing the electrostatic latent image using toner, and a transfer roller **302** that transfers the toner image to the transfer belt. Note that the exposure device may be provided outside the development station **203**.
(34) The printing apparatus **107** has a monochrome mode and a full-color mode. The monochrome mode is a mode in which a toner image is formed using black toner alone. The full-color mode is a mode in which toner images are formed using sets of toner corresponding to YMCK. In the monochrome mode, the development stations **203***d*, **203***c*, and **203***b* corresponding to YMC are not used. Thus, in the monochrome mode, the development stations **203***d*, **203***c*, and **203***b* are separated from the transfer belt **204**. As a result, abrasion of the photosensitive drums corresponding to YMC is alleviated. Note that even if the development stations **203***d*, **203***c*, and **203***b* are in contact with the transfer belt **204**, a monochrome image that uses only black toner can be formed.
(35) FIG. **3**A shows a full-contact state (a full in-touch state), whereas FIG. **3**B shows a single-contact state (a single in-touch state). In FIG. **3**A, the transfer rollers **302***a* to **302***d* are in contact with an inner circumferential surface of the transfer belt **204**, and holding the transfer belt **204** between themselves and the photosensitive drums **301***a* to **301***d*. This is referred to as the full-contact state. In FIG. **3**B, the transfer rollers **302***b* to **302***d* are separated from the inner circumferential surface of the transfer belt **204**. This makes the transfer belt **204** separated from the photosensitive drums **301***b* to **301***d*. That is to say, only the photosensitive drum **301***a* is in contact with the transfer belt **204**. This is referred to as the single-contact state. Here, the change in the contact state is realized by the movement of the transfer rollers **302***b* to **302***d*. However, the movement of the transfer rollers **302***b* to **302***d* is relative. Therefore, the contact state may change as a result of the movement of the photosensitive drums **301***b* to **301***d*.
(36) A motor **311** is a driving source that switches the state of contact between the transfer belt **204** and the photosensitive drums **301***b* to **301***d* to an in-touch state or a separated state. A light shielding plate **313** is joined directly or indirectly to a rotation shaft of the motor **311**, and the position at which it is located differs between the in-touch state and the separated state. The light shielding plate **313** detects the in-touch state or the separated state in coordination with an optical HP sensor **312**. HP is an acronym for a home position. The HP sensor **312** includes a light emitting element and a light receiving element. In the in-touch state, light output from the light emitting element is shielded by the light shielding plate **313**, and cannot be made incident on the light receiving element. On the other hand, in the separated state, light output from the light emitting element is not shielded by the light shielding plate **313**, and can be made incident on the light receiving element. Therefore, an output signal from the light emitting element in the in-touch state, and an output signal from the light emitting element in the separated state, are signals that can be distinctively discriminated from each other. Thus, the printing apparatus **107** can discriminate the in-touch state (full-contact state) and the separated state (single-contact state) from each other based on an output signal (detection signal) from the HP sensor **312**.
(37) (Image Reading Apparatus)
(38) As shown in FIG. **4**, the CIS unit **207***a* is placed so as to read an upper surface of a sheet P, whereas the CIS unit **207***b* is placed so as to read a lower surface of the sheet P. The upper surface

may also be referred to as a front surface or a first surface. The lower surface may also be referred to as a back surface or a second surface. The CIS units **207** include a light source **401** that illuminates the sheet P, an image sensor **402** that reads the sheet P, and a white reference plate **403**. The light source **401** is a light emitting element, such as a white light-emitting diode (LED). The image sensor **402** is a CCD image sensor, a CMOS image sensor, or the like. CCD is an acronym for a charge-coupled device. CMOS is an acronym for a complementary metal-oxide-semiconductor. The white reference plate **403** serves as a base for a while color of an image read by the image sensor **402**.

(39) In embodiments, the CIS units **207***a* and **207***b* read test images that have been respectively formed on both surfaces of the sheet P. When the internal temperature of the printing apparatus **107** has increased, the positions of images formed on the sheet P fluctuate compared to a case where the internal temperature of the printing apparatus **107** is low. In view of this, the printing apparatus **107** obtains the amounts of fluctuations in image forming positions based on the reading result of the test images, and adjusts the image forming positions based on the obtained amounts of fluctuations. Consequently, the accuracy of the image forming positions increases. In particular, in the present embodiment, the image forming position on the front surface of the sheet P and the image forming position on the back surface of the sheet P are brought into consistency with each other.

(40) (Method of Generating Correction Values for Image Forming Positions)

(41) FIG. **5** shows test patterns **501***a* to **501***d* formed at four corners of a front surface **500***a* of a sheet P, and test patterns **502***a* to **502***d* formed at four corners of a back surface **500***b* thereof. In the present example, each of the test patterns (pattern images) **501***a* to **501***d* and **502***a* to **502***d* is a V-shaped pattern made up of two line segments. A junction (vertex) of two line segments acts as a target of measurement of an image forming position.

(42) FIG. **6**A is a diagram for describing a method of obtaining a correction value for image scaling. Toner images transferred to the sheet P are fixed on the sheet P as a result of passing through the fixing devices **206***a* and **206***b*. At this time, as the sheet P is heated by the fixing devices **206***a* and **206***b*, moisture contained in the sheet P evaporates, and the sheet P shrinks. An image is formed on the back surface of this sheet P that has shrank. Thereafter, the sheet P absorbs moisture, and reverts to the original size. Consequently, the image on the back surface of the sheet P becomes larger than the image on the front surface thereof. In view of this, image scaling correction for bringing the size of the image on the front surface of the sheet P into consistency with the size of the image on the back surface thereof is required. The image scaling correction is achieved by reducing toner images on the back surface in advance. The extent of the reduction is dependent on the result of actual measurement of the test patterns **501***a* to **501***d* and **502***a* to **502***d*.

(43) FIG. **6**A shows a method of measurement of the test patterns **501***a* to **501***d* formed on the front surface **500***a*, as one example. A method of measurement of the test patterns **502***a* to **502***d* formed on the back surface **500***b* is similar. Therefore, below, the test patterns **501***a* to **501***d* can be read as the test patterns **502***a* to **502***d*. An arrow **600** indicates the conveyance direction. Here, it is assumed that the conveyance direction (sub scanning direction) is parallel to the short edges of the sheet P. The main scanning direction is a direction that is perpendicular to the arrow **600**; in the present example, the main scanning direction is parallel to the long edges of the sheet P.

(44) Len (a−b) is a distance between an intersection of two line segments of the test pattern **501***a* and an intersection of two line segments of the test pattern **501***b*. Len (b−c) is a distance between an intersection of two line segments of the test pattern **501***b* and an intersection of two line segments of the test pattern **501***c*. In this case, a correction value CMma for main scanning scaling on the front surface **500***a* is obtained from the following expression.

(45) $\mathrm{CMma} = \mathrm{Len\_main} / \mathrm{Len}(a - b)$ (1)

Here, Len_main is the length that serves as a base for scaling in the main scanning direction. A correction value CMmb for main scanning scaling on the back surface **500***b* is also obtained by

applying expression (1) to the reading result of the back surface **500***b*. Note that the method of describing correction values is as follows. C as the first letter denotes a correction value, M as the second letter denotes scaling correction, m as the third letter denotes the main scanning direction, and a as the fourth letter denotes the front surface. Note that S as the second letter denotes correction of the position at which writing is started, s as the third letter denotes the sub scanning direction, and b as the fourth letter denotes the back surface.
(46) A correction value CMsa for scaling in the sub scanning direction on the front surface **500***a* is obtained from the following expression.
(47) $CMsa = Len\_sub / Len(b - c) \quad (2)$
Here, Len_sub is the length that serves as a base for scaling in the sub scanning direction. A correction value CMsb for sub scanning scaling on the back surface **500***b* is also obtained by applying expression (2) to the reading result of the back surface **500***b*.
(48) FIG. **6**B is a diagram for describing a method of correcting the position at which image writing is started in the main scanning direction. An arrow **601** indicates the main scanning direction. Len (side−a) is a distance from an edge portion of the sheet P in the main scanning direction to an intersection of two line segments of the test pattern **501***a*. Len (side−b) is a distance from an edge portion of the sheet P in the main scanning direction to an intersection of two line segments of the test pattern **501***b*. Here, the position at which image writing is started in the main scanning direction is corrected so that Len (side−a) and Len (side−b) become equal to each other. As a result, an image is placed at the center of the sheet P in the main scanning direction. A correction value CSma for the position at which image writing is started in the main scanning direction is calculated from the following expression.
(49) $CSma = (-1 \times (Len(side - a) - Len(side - b)) / 2) + (-1 \times ((Len\_main - Len(a - b)) / 2)) \quad (3)$
In a case where the correction value CSma has a negative value, the position at which image writing is started is corrected so as to accelerate the timing at which writing is started in the main scanning direction. In a case where the correction value CSma has a positive value, the position at which image writing is started is corrected so as to delay the timing at which writing is started in the main scanning direction. Note that a correction value CSmb for the back surface is also obtained by applying expression (3) to the reading result of the back surface **500***b*.
(50) FIG. **6**B also shows how to obtain a correction value for the position at which image writing is started in the sub scanning direction. Len (top−a) is a distance from an edge portion (a top edge) of the sheet P in the sub scanning direction to an intersection of two line segments of the test pattern **501***a*. Len (tail−d) is a distance from an edge portion (a tail edge) of the sheet P in the sub scanning direction to an intersection of two line segments of the test pattern **501***d*. The position at which image writing is started in the sub scanning direction is corrected so that Len (top−a) and Len (tail−d) become equal to each other. As a result, an image is placed at the center of the sheet P in the sub scanning direction. A correction value CSsa for the position at which image writing is started on the front surface **500***a* in the sub scanning direction is obtained from the following expression.
(51) $CSsa = (-1 \times (Len(top - a) - Len(tail - b)) / 2) + (-1 \times (Len\_sub - Len(b - c)) / 2) \quad (4)$
In a case where the correction value CSsa has a negative value, the position at which image writing is started is corrected so as to accelerate the timing at which image writing is started in the sub scanning direction. In a case where the correction value CSsa has a positive value, the position at which image writing is started is corrected so as to delay the timing at which image writing is started in the sub scanning direction. A correction value CSsb for the position at which image writing is started on the back surface **500***b* in the sub scanning direction is also obtained by applying expression (4) to the reading result of the back surface **500***b*.
(52) According to the present embodiment, the image forming position on the front surface of the sheet P and the image forming position on the back surface thereof can be brought into consistency

with each other. For example, the main scanning scaling on the front surface and the main scanning scaling on the back surface coincide with each other. Furthermore, the sub scanning scaling on the front surface coincides with the sub scanning scaling on the back surface. In addition, the position at which image writing is started on the front surface in the main scanning direction coincides with the position at which image writing is started on the back surface in the main scanning direction. Moreover, the position at which image writing is started on the front surface in the sub scanning direction coincides with the position at which image writing is started on the back surface in the sub scanning direction. Consequently, the accuracy of the image forming positions increases.

(53) (Functions of CPU)

(54) FIG. **7** shows an internal controller of the printing apparatus **107**. A CPU **701** realizes various functions in accordance with a control program stored in a read-only memory (ROM) region of a memory **702**. Note that a part or all of these functions may be implemented on a hardware circuit, such as an ASIC or an FPGA, provided outside the CPU **701**. This is because program modules that compose the control program can be realized by a logic circuit, and the logic circuit can be realized by the program modules. ASIC is an acronym for an application-specific integrated circuit. FPGA is an acronym for a field-programmable gate array. The CPU, ASIC, FPGA, and the like may be referred to as processors or processing circuits.

(55) The memory **702** includes a random-access memory (RAM) region, and temporarily stores data in the RAM region. Note that the memory **702** may include a high-speed image memory for deployment of image data. The memory **702** may include a solid-state drive (SSD) or a hard disk drive (HDD). The CPU **701** communicates with the external controller **102** or the client PC **103**, and communicates with the finisher **109**, via a communication circuit **703**. The CPU **701** displays information on the display apparatus of the operation unit **225**, and accepts instructions input from the input apparatuses of the operation unit **225**.

(56) The CPU **701** outputs image signals to an exposure device **730**, and obtains the reading result from the CIS units **207***a* and **207***b*. The CPU **701** controls the development stations **203***a* to **203***d*, and controls the fixing devices **206***a* and **206***b*.

(57) The CPU **701** causes a motor **704** to drive a large number of conveyance roller pairs **202**, and to drive the feeding decks **201***a* and **201***b*, by controlling the motor **704**. Although one motor **704** is depicted here, a plurality of motors may be used in practice.

(58) A test unit **710** executes various types processing for obtaining the correction values CMma, CMmb, CMsa, CMsb, CSma, CSmb, CSsa, and CSsb for image forming positions. For example, a pattern generation unit **711** generates image data for forming the test patterns **501***a* to **501***d* on the front surface **500***a* of the sheet P. The pattern generation unit **711** generates image data for forming the test patterns **502***a* to **502***d* on the back surface **500***b* of the sheet P. These pieces of image data may be pieces of data that are supplied to the exposure device **730**, or may be pieces of data that are supplied to the exposure device **730** via an image processing unit **722**.

(59) A measurement unit **712** obtains the reading result of the front surface **500***a* from the CIS unit **207***a*, and measures the positions of respective intersections in the test patterns **501***a* to **501***d*. The measurement unit **712** obtains the reading result of the back surface **500***b* from the CIS unit **207***b*, and measures the positions of respective intersections in the test patterns **502***a* to **502***d*.

(60) A correction value determination unit **713** determines various types of correction values based on the result of measurement output from the measurement unit **712**. For example, the correction value determination unit **713** determines various types of correction values by applying expression (1) to expression (4) to the result of measurement output from the measurement unit **712**. Note that Len (a−b), Len (b−c), Len (side−a), Len (side−b), Len (top−a), and Len (tail−d) may be calculated by the measurement unit **712**, or may be calculated by the correction value determination unit **713**. Such fixed values as Len_main and Len_sub are held in the ROM region of the memory **702**.

(61) A correction unit **721** corrects the positions of formation of an image based on the correction values determined by the correction value determination unit **713**. For example, the correction unit

721 corrects the main scanning scaling and the sub scanning scaling by making a minute change to scaling of the image based on the correction values. The correction unit **721** corrects the position at which image writing is started by adjusting the timing to supply image signals to the exposure device **730** based on the correction values.

(62) The image processing unit **722** generates image signals by converting a color space of the pieces of image data and executing tone correction, and supplies the image signals to the exposure device **730**. A conveyance control unit **723** controls the motor **704**. Upon receiving a jam notification from the finisher **109**, the conveyance control unit **723** switches the flapper **208**, and conveys the sheet P to the discharge tray **210**. The conveyance control unit **723** controls the flapper **208** so that sheets P on which the test patterns **501** and **502** have been formed (test charts) are also conveyed to the discharge tray **210**.

(63) An in-touch control unit **724** realizes the full-contact state by controlling the motor **311** in the full-color mode. The in-touch control unit **724** realizes the single-contact state by controlling the motor **311** in the monochrome mode. The in-touch control unit **724** may confirm the completion of a transition from the full-contact state to the single-contact state, as well as the completion of a transition from the single-contact state to the full-contact state, based on a detection signal from the HP sensor **312**.

(64) An environment sensor **760**, which is optional, measures environmental conditions (e.g., the temperature and humidity) inside the printing apparatus **107**. The CPU **701** may obtain the environmental conditions periodically, and execute an update of the correction values if the amounts of fluctuations in the environmental conditions exceed thresholds. A counter **725** counts the number (quantity) of sheets on which images have been formed. The CPU **701** may execute the generation or update of the correction values if the value counted by the counter **725** reaches a threshold.

(65) FIG. **8** shows an internal controller of the finisher **109**. A CPU **801** controls the finisher **109** in accordance with a control program stored in a memory **802**. The CPU **801** communicates with the CPU **701** via a communication circuit **803**. A conveyance control unit **811** drives the conveyance roller pairs provided inside the finisher **109** by controlling a motor **805**. A jam detection unit **812** detects the occurrence of a jam inside the finisher **109** based on the result of detection performed by the sheet sensors **212***a* to **212***d*. When the jam detection unit **812** has detected the occurrence of a jam, a jam notification unit **813** issues a jam notification, and transmits the jam notification to the CPU **701** via the communication circuit **803**.

(66) (User Interface)

(67) FIGS. **9**A to **9**D show examples of setting screens **900***a* to **900***d* that are displayed on the display apparatus of the operation unit **225**. As stated earlier, a sheet P comes in a wide variety of types. For example, there are a plurality of types of sheets P that have the same basis weight but have different moisture absorption states or physical properties. These plurality of types of sheets P can have different contraction characteristics after passing through the fixing devices **206***a* and **206***b*. In order to correct the front and back image forming positions with higher accuracy, it is necessary to generate the above-described correction values for each of the types of sheets P.

(68) The setting screen **900***a* includes a button **901***a* for selecting an application mode. Upon detecting that the user has operated the button **901***a*, the CPU **701** displays the setting screen **900***b* on the operation unit **225**.

(69) The setting screen **900***b* includes a button **901***b* for registering a sheet. Upon detecting that the user has operated the button **901***b*, the CPU **701** displays the setting screen **900***c* on the operation unit **225**.

(70) The setting screen **900***c* accepts registration of a sheet name, a sheet size, a basis weight, and a type of a front surface of a sheet (e.g., standard paper, coated paper, and embossed paper). Note that the type of the front surface of the sheet is information on the front surface of the sheet. The sheet name may be a brand of a product, or may be a name that has been arbitrarily given by the user.

Furthermore, the setting screen **900***c* includes a button **901***c* for supporting the printing of the test patterns **501** and **502** and the generation of correction values. Upon detecting that the user has operated the button **901***c*, the CPU **701** displays the setting screen **900***d* on the operation unit **225**. Pressing the button **901***c* enables correction of the image forming positions using the correction values held in the memory **702**.
(71) The setting screen **900***d* accepts a designation of the feeding deck **201** that stores a sheet P on which the test patterns **501** and **502** are to be formed, and an instruction for starting the correction. Upon detecting that the user has operated the button **901***d*, the CPU **701** instructs the test unit **710** to start the generation of the test patterns **501** and **502** and the generation of correction values.
(72) (Flowchart)
(73) FIG. **10** is a flowchart showing a method of generating correction values for each of the types of sheets P. Here, in order to increase the accuracy of determination of correction values, test images (test patterns **501** and **502**) are formed on N sheets P. Furthermore, feeding of sheets P from the feeding deck **201***a* has been designated via the setting screen **900***d*. When the button **901***d* has been pressed on the setting screen **900***d*, the CPU **701** executes the following processing.
(74) In step S**1001**, the CPU **701** switches the print mode from the monochrome mode (single-contact state) to the full-color mode (full-contact state). The CPU **701** (in-touch control unit **724**) switches the development stations **203***b* to **203***d* from the separated state to the in-touch state by controlling the motor **311**.
(75) In step S**1002**, the CPU **701** forms a test image on the front surface **500***a* of a sheet P. The conveyance control unit **723** feeds a sheet P from the feeding deck **201***a* designated by the user. The pattern generation unit **711** supplies a test image signal for the front surface **500***a* to the exposure device **730**. The exposure device **730** exposes the photosensitive drums **301** to light; as a result, electrostatic latent images are formed. The development stations **203** form toner images by developing the electrostatic latent images using toner. The transfer rollers **302** transfer the toner images from the photosensitive drums **301** to the transfer belt **204**. The secondary transfer unit **205** transfers the toner images from the transfer belt **204** to the front surface **500***a* of the sheet P. The fixing devices **206** fix the toner images on the front surface **500***a* of the sheet P.
(76) In step S**1003**, the CPU **701** forms a test image on the back surface **500***b* of the sheet P. The conveyance control unit **723** sends the sheet P from the conveyance path R**6** back to the conveyance path R**1**. The pattern generation unit **711** supplies a test image signal for the back surface **500***b* to the exposure device **730**. The exposure device **730** exposes the photosensitive drums **301** to light; as a result, electrostatic latent images are formed. The development stations **203** form toner images by developing the electrostatic latent images using toner. The transfer rollers **302** transfer the toner images from the photosensitive drums **301** to the transfer belt **204**. The secondary transfer unit **205** transfers the toner images from the transfer belt **204** to the back surface **500***b* of the sheet P. The fixing devices **206** fix the toner images on the back surface **500***b* of the sheet P.
(77) In step S**1004**, the CPU **701** reads the front surface **500***a* of the sheet P. For example, the CPU **701** causes the CIS unit **207***a* to read the front surface **500***a* of the sheet P by controlling the same, obtains the result of reading, and stores the result of reading into the memory **702**.
(78) In step S**1005**, the CPU **701** reads the back surface **500***b* of the sheet P. For example, the CPU **701** causes the CIS unit **207***b* to read the back surface **500***b* of the sheet P by controlling the same, obtains the result of reading, and stores the result of reading into the memory **702**.
(79) In step S**1006**, the CPU **701** determines whether the reading of N sheets P has been completed. If the reading of N sheets P has been completed, the CPU **701** causes processing to proceed to step S**1007**. If the reading of N sheets P has not been completed, the CPU **701** causes processing to proceed to step S**1002**.
(80) In step S**1007**, the CPU **701** determines correction values for the full-color mode (full-contact state). The CPU **701** (correction value determination unit **713**) applies statistical processing (e.g.,

averaging) to the results of reading obtained from the N sheets P to reduce the influence of reading errors. Furthermore, the CPU **701** (correction value determination unit **713**) determines various types of correction values by applying expression (1) to expression (7) to the results of reading to which the statistical processing has been applied.

(81) In step S**1008**, the CPU **701** switches the print mode from the full-color mode (full-contact state) to the monochrome mode (single-contact state). The CPU **701** (in-touch control unit **724**) switches the development stations **203***b* to **203***d* from the in-touch state to the separated state by controlling the motor **311**.

(82) In step S**1009**, the CPU **701** forms a test image on the front surface **500***a* of a sheet P. The conveyance control unit **723** feeds a sheet P from the feeding deck **201***a* designated by the user. The pattern generation unit **711** supplies a test image signal for the front surface **500***a* to the exposure device **730**. The exposure device **730** exposes the photosensitive drum **301** to light; as a result, an electrostatic latent image is formed. The development station **203** forms a toner image by developing the electrostatic latent image using toner. The transfer roller **302** transfers the toner image from the photosensitive drum **301** to the transfer belt **204**. The secondary transfer unit **205** transfers the toner image from the transfer belt **204** to the front surface **500***a* of the sheet P. The fixing devices **206** fix the toner image on the front surface **500***a* of the sheet P.

(83) In step S**1010**, the CPU **701** forms a test image on the back surface **500***b* of the sheet P. The conveyance control unit **723** sends the sheet P from the conveyance path R**6** back to the conveyance path R**1**. The pattern generation unit **711** supplies a test image signal for the back surface **500***b* to the exposure device **730**. The exposure device **730** exposes the photosensitive drum **301** to light; as a result, an electrostatic latent image is formed. The development station **203** forms a toner image by developing the electrostatic latent image using toner. The transfer roller **302** transfers the toner image from the photosensitive drum **301** to the transfer belt **204**. The secondary transfer unit **205** transfers the toner image from the transfer belt **204** to the back surface **500***b* of the sheet P. The fixing devices **206** fix the toner image on the back surface **500***b* of the sheet P.

(84) In step S**1011**, the CPU **701** reads the front surface **500***a* of the sheet P. For example, the CPU **701** causes the CIS unit **207***a* to read the front surface **500***a* of the sheet P by controlling the same, obtains the result of reading, and stores the result of reading into the memory **702**.

(85) In step S**1012**, the CPU **701** reads the back surface **500***b* of the sheet P. For example, the CPU **701** causes the CIS unit **207***b* to read the back surface **500***b* of the sheet P by controlling the same, obtains the result of reading, and stores the result of reading into the memory **702**.

(86) In step S**1013**, the CPU **701** determines whether the reading of M sheets P has been completed. If the reading of M sheets P has been completed, the CPU **701** causes processing to proceed to step S**1014**. If the reading of M sheets P has not been completed, the CPU **701** causes processing to proceed to step S**1009**. Note that N and M may be the same as, or may be different from, each other. N and M may be designated or selected by the user via the operation unit **225**.

(87) In step S**1014**, the CPU **701** determines correction values for the monochrome mode (single-contact state). The CPU **701** (correction value determination unit **713**) applies statistical processing (e.g., averaging) to the results of reading obtained from the M sheets P to reduce the influence of reading errors. Furthermore, the CPU **701** (correction value determination unit **713**) determines various types of correction values by applying expression (1) to expression (7) to the results of reading to which the statistical processing has been applied.

(88) In step S**1015**, the CPU **701** registers the correction values in association with identification information of the sheets P. That is to say, the correction values are written into the ROM region of the memory **702**.

(89) (Database)

(90) FIG. **11** shows an example of a record **1100** in a database that manages correction values. This database is held in the memory **702**, and the record **1100** is added or updated in step S**1015**. The database may be held in a storage server provided outside the image forming apparatus **101**, such

as the external controller **102**.

(91) A field **1101** stores a media ID. This is one type of identification information for identifying a sheet P. The field **1101** also functions as an ID for identifying the record **1100**.

(92) A field **1102** stores the name of the sheet P that has been registered by the user via the setting screen **900***c*. A field **1103** stores the length of the sheet P in the main scanning direction that has been registered by the user via the setting screen **900***c*. A field **1104** stores the length of the sheet P in the sub scanning direction that has been registered by the user via the setting screen **900***c*. A field **1105** stores the type of the sheet P that has been registered by the user via the setting screen **900***c* (e.g., standard paper, coated paper, embossed paper, or the like). A field **1106** stores the basis weight of the sheet P that has been registered by the user via the setting screen **900***c*.

(93) A field **1107** to a field **1114** store correction values in the full-contact state (full-color mode). Especially, the field **1107** to the field **1110** store correction values CS for the positions at which writing is started. The field **1111** to the field **1114** store correction values CM for scaling. The field **1107** stores the correction value CSma for the front surface along the main scanning direction. The field **1108** stores the correction value CSsa for the front surface along the sub scanning direction. The field **1109** stores the correction value CSmb for the back surface along the main scanning direction. The field **1110** stores the correction value CSsb for the back surface along the sub scanning direction. The field **1111** stores the correction value CMma for the front surface along the main scanning direction. The field **1112** stores the correction value CMsa for the front surface along the sub scanning direction. The field **1113** stores the correction value CMmb for the back surface along the main scanning direction. The field **1114** stores the correction value CMsb for the back surface along the sub scanning direction.

(94) A field **1115** to a field **1122** store correction values in the single-contact state (monochrome mode). Especially, the field **1115** to the field **1118** store correction values CS for the positions at which writing is started. The field **1119** to the field **1122** store correction values CM for scaling. The field **1115** stores the correction value CSma for the front surface along the main scanning direction. The field **1116** stores the correction value CSsa for the front surface along the sub scanning direction. The field **1117** stores the correction value CSmb for the back surface along the main scanning direction. The field **1118** stores the correction value CSsb for the back surface along the sub scanning direction. The field **1119** stores the correction value CMma for the front surface along the main scanning direction. The field **1120** stores the correction value CMsa for the front surface along the sub scanning direction. The field **1121** stores the correction value CMmb for the back surface along the main scanning direction. The field **1122** stores the correction value CMsb for the back surface along the sub scanning direction.

(95) (Correction Method)

(96) FIG. **12** is a flowchart showing a method of selecting correction values in accordance with the print mode. When the user has issued an instruction for image formation from the client PC **103** or the operation unit **225**, the CPU **701** executes the following processing.

(97) In step S**1201**, the CPU **701** determines whether a print target is a color image. The CPU **701** determines whether the print target is the color image by analyzing image data, or by analyzing the content of the print target. If the print target is the color image, the CPU **701** causes processing to proceed to step S**1202**.

(98) In color printing, in which a color image (color toner image) is formed on a sheet, the contact state is controlled to be the full-contact state. In step S**1202**, the CPU **701** sets the development stations **203***b* to **203***d* in the full-contact state. For example, the CPU **701** (in-touch control unit **724**) switches the development stations **203***b* to **203***d* from the separated state to the in-touch state by controlling the motor **311**. Thereafter, the CPU **701** causes processing to proceed to step S**1203**.

(99) If the print target is a monochrome image, the CPU **701** causes processing to proceed from step S**1201** to step S**1211**. In monochrome printing, in which a monochrome image (black toner image) is formed on a sheet, the contact state is controlled to be the single-contact state. In step

S**1211**, the CPU **701** sets the development stations **203***b* to **203***d* in the single-contact state. For example, the CPU **701** (in-touch control unit **724**) switches the development stations **203***b* to **203***d* from the in-touch state to the separated state by controlling the motor **311**. Thereafter, the CPU **701** causes processing to proceed to step S**1203**.

(100) In step S**1203**, the CPU **701** determines whether correction of the front and back image forming positions has been enabled. For example, if the button **901***c* has been pressed down in advance, the CPU **701** determines that correction of the front and back image forming positions has been enabled, and causes processing to proceed to step S**1204**. If the button **901***c* has not been pressed down in advance, the CPU **701** determines that correction of the front and back image forming positions has not been enabled, and causes processing to proceed to step S**1207**. The button **901***c* is one type of toggle switch. Note that whether correction has been enabled or disabled may be determined based on whether correction values are stored in the fields **1107** to **1122** in the database held in the memory **702**.

(101) In step S**1204**, the CPU **701** determines whether the development stations **203***b* to **203***d* are in the full-contact state. For example, the CPU **701** may execute a determination similar to the determination of step S**1201**. Alternatively, the CPU **701** may determine whether the development stations **203***b* to **203***d* are in the full-contact state based on the result of detection performed by the HP sensor **312**. If the development stations **203***b* to **203***d* are in the full-contact state, the CPU **701** causes processing to proceed to step S**1205**.

(102) In step S**1205**, the CPU **701** reads out the correction values for the full-contact state from the memory **702**. That is to say, the correction values are read out from the fields **1107** to **1114** corresponding to the type, the identification information, and the record of the sheet P designated by the user, and the correction values are set in the correction unit **721**.

(103) If the development stations **203***b* to **203***d* are in the single-contact state, the CPU **701** causes processing to proceed from step S**1204** to step S**1221**.

(104) In step S**1221**, the CPU **701** reads out the correction values for the single-contact state from the memory **702**. That is to say, the correction values are read out from the fields **1115** to **1122** corresponding to the type, the identification information, and the record of the sheet P designated by the user, and the correction values are set in the correction unit **721**.

(105) In step S**1206**, the CPU **701** corrects the image forming positions in accordance with the correction values that have been read out. Consequently, the positions at which image writing is started, as well as scaling, are appropriately corrected.

(106) In step S**1207**, the CPU **701** executes image formation.

(107) In step S**1208**, the CPU **701** determines whether the entire printing has been completed based on a print job. If the entire printing has not been completed, the CPU **701** causes processing to proceed to step S**1201**. If the entire printing has been completed, the CPU **701** ends the processing sequence.

(108) Note that while black test patterns **501** and **502** can be formed in the single-contact state, test patterns **501** and **502** in any of YMCK can be formed in the full-contact state. Therefore, in the full-contact state, the test patterns **501** and **502** in four colors, namely YMCK, may be formed on one sheet P in such a manner that they do not overlap one another. Alternatively, the test patterns **501** and **502** in four colors, namely YMCK, may be formed on different sheets P. Alternatively, measured values obtained by using the test patterns **501** and **502** in any one of the colors may be used as measured values for the remaining three colors.

(109) The development station **203***a* that includes the photosensitive drum **301***a* is one example of a black image forming unit that includes a photosensitive member. The development stations **203***b* to **203***d* that include the photosensitive drums **301***b* to **301***d* are examples of a plurality of color image forming units that include photosensitive members. The transfer belt **204** is one example of an intermediate transfer member. The motor **311** is one example of a mechanical mechanism that controls the state of contact between the photosensitive drums **301***a* to **301***d* and the intermediate

transfer belt **204**. The secondary transfer unit **205** is one example of a transfer unit. The fixing devices **206** are examples of a fixing unit. The CIS units **207** are examples of a reading unit that reads a first surface and a second surface of a sheet P. The CPU **701** is one example of a controller that generates data used to adjust image forming positions. The CPU **701** and the correction unit **721** are examples of the controller that controls an image forming position of a first toner image based on first data in the full-color mode (full-contact state). The CPU **701** and the correction unit **721** are examples of the controller that controls an image forming position of a second toner image based on second data in the monochrome mode (single-contact state).
OTHER EMBODIMENTS
(110) Embodiment(s) of the present disclosure can also be realized by a computer of a system or apparatus that reads out and executes computer executable instructions (e.g., one or more programs) recorded on a storage medium (which may also be referred to more fully as a 'non-transitory computer-readable storage medium') to perform the functions of one or more of the above-described embodiment(s) and/or that includes one or more circuits (e.g., application specific integrated circuit (ASIC)) for performing the functions of one or more of the above-described embodiment(s), and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the computer executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s) and/or controlling the one or more circuits to perform the functions of one or more of the above-described embodiment(s). The computer may comprise one or more processors (e.g., central processing unit (CPU), micro processing unit (MPU)) and may include a network of separate computers or separate processors to read out and execute the computer executable instructions. The computer executable instructions may be provided to the computer, for example, from a network or the storage medium. The storage medium may include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD)™), a flash memory device, a memory card, and the like.
(111) While the present disclosure has been described with reference to embodiments, it is to be understood that the disclosure is not limited to the disclosed embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

Claims

1. An image forming apparatus comprising: an image forming unit configured to form an image, the image forming unit including a first image carrier on which a black image is formed, and a second image carrier on which a color image different from the black image is formed; a belt member to which the black image and the color image are transferred; a transfer unit configured to transfer the black image and the color image from the belt member to a sheet; a mechanical mechanism configured to control contact states between the first image carrier and the belt member and between the second image carrier and the belt member, the contact states including: a first contact state in which the first image carrier is in contact with the belt member and the second image carrier is separated from the belt member; and a second contact state in which the first image carrier is in contact with the belt member and the second image carrier is in contact with the belt member; a controller configured to control the image forming unit and the mechanical mechanism to form, in the first contact state, a test image for the first contact state, the test image for the first contact state to be used for adjusting an image formation position of an image on a sheet to be formed in the first contact state, and control the image forming unit and the mechanical mechanism to form, in the second contact state, a test image for the second contact state, the test image for the second contact state to be used for adjusting an image formation position of an image on a sheet to

be formed in the second contact state.

2. The image forming apparatus according to claim 1, further comprising a reader configured to read an image on a sheet, wherein the controller is further configured to adjust an image formation position of an image on a sheet to be formed in the first contact state based on a reading result of the test image for the first contact state read by the reader, and the controller is further configured to adjust an image formation position of an image on a sheet to be formed in the second contact state based on a reading result of the test image for the second contact state read by the reader.

3. The image forming apparatus according to claim 2, further comprising a tray on which a sheet is discharged, wherein the reader reads the image on the sheet while the sheet is conveyed from the image forming unit to the tray.

4. The image forming apparatus according to claim 2, further comprising a fixing unit configured to fix an image transferred to a sheet by the transfer unit to the sheet, wherein the reader is situated downstream relative to the fixing unit in a direction in which the sheet is conveyed and reads the image on the sheet.

5. The image forming apparatus according to claim 1, wherein the image formation position comprise a position at which write of an image to be formed is started.

6. The image forming apparatus according to claim 1, wherein the adjusting of the image formation position comprise scaling an image to be formed.

7. The image forming apparatus according to claim 1, wherein the image forming unit forms an image based on image data, and the mechanical mechanism alternates the contact states based on the image data.

8. The image forming apparatus according to claim 1, wherein the test image for the first contact state is a mark formed on both surfaces of a sheet, and the test image for the second contact state is a mark formed on both surfaces of sheet.

9. The image forming apparatus according to claim 1, wherein both the test image for the first contact state and the test image for the second contact state are marks formed in black.

10. The image forming apparatus according to claim 1, wherein the test image for the first contact state includes a V-shaped mark.

11. An image forming apparatus comprising: an image forming unit configured to form an image, the image forming unit including a first image carrier on which a first image in a first color is formed, and a second image carrier on which a second image in a second color different from the first color is formed; a belt member to which the first image and the second image are transferred; a transfer unit configured to transfer the first image and the second image from the belt member to a sheet; a mechanical mechanism configured to control contact states between the first image carrier and the belt member and between the second image carrier and the belt member, the contact states including: a first contact state in which the first image carrier is in contact with the belt member and the second image carrier is separated from the belt member; and a second contact state in which the first image carrier is in contact with the belt member and the second image carrier is in contact with the belt member; a controller configured to control the image forming unit and the mechanical mechanism to form, in the first contact state, a test image for the first contact state, the test image for the first contact state to be used for adjusting an image formation position of an image on a sheet to be formed in the first contact state, and control the image forming unit and the mechanical mechanism to form, in the second contact state, a test image for the second contact state, the test image for the second contact state to be used for adjusting an image formation position of an image on a sheet to be formed in the second contact state.

12. The image forming apparatus according to claim 11, further comprising a reader configured to read an image on a sheet, wherein the controller is further configured to adjust an image formation position of an image on a sheet to be formed in the first contact state based on a reading result of the test image for the first contact state read by the reader, and the controller is further configured to adjust an image formation position of an image on a sheet to be formed in the second contact

state based on a reading result of the test image for the second contact state read by the reader.

13. The image forming apparatus according to claim 12, further comprising a tray on which a sheet is discharged, wherein the reader reads the image on the sheet while the sheet is conveyed from the image forming unit to the tray.

14. The image forming apparatus according to claim 12, further comprising a fixing unit configured to fix an image transferred to a sheet by the transfer unit to the sheet, wherein the reader is situated downstream relative to the fixing unit in a direction in which the sheet is conveyed and reads the image on the sheet.

15. The image forming apparatus according to claim 11, wherein the image formation position comprise a position at which write of an image to be formed is started.

16. The image forming apparatus according to claim 11, wherein the adjusting of the image formation position comprise scaling an image to be formed.

17. The image forming apparatus according to claim 11, wherein the image forming unit forms an image based on image data, and the mechanical mechanism alternates the contact states based on the image data.

18. The image forming apparatus according to claim 11, wherein the test image for the first contact state is a mark formed on both surfaces of a sheet, and the test image for the second contact state is a mark formed on both surfaces of sheet.

19. The image forming apparatus according to claim 11, wherein both the test image for the first contact state and the test image for the second contact state are marks formed in black.

20. The image forming apparatus according to claim 11, wherein the test image for the first contact state includes a V-shaped mark.