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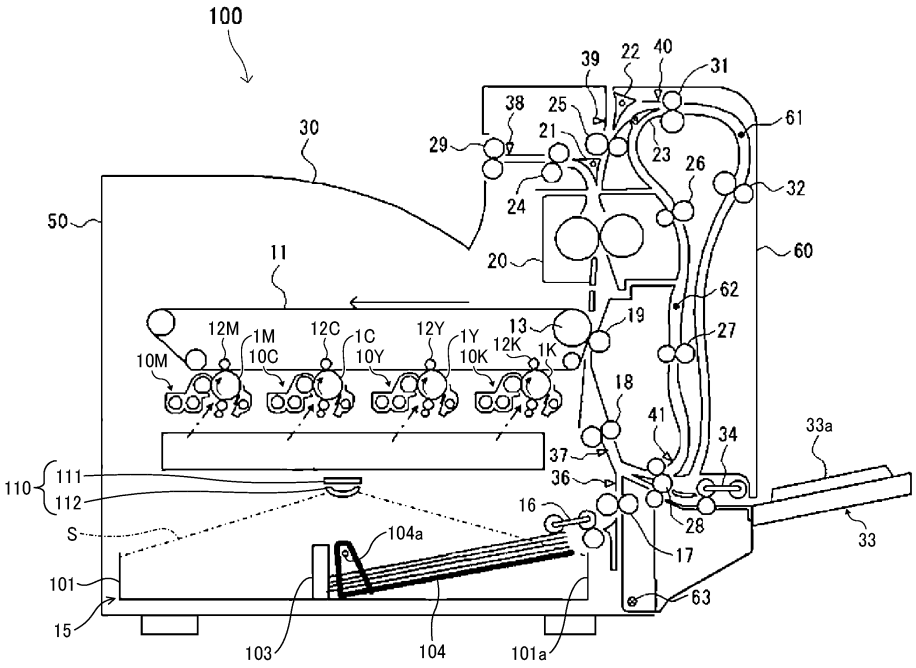
(54) SHEET STACKING DEVICE AND IMAGE FORMING APPARATUS INCORPORATING THE SHEET STACKING DEVICE

(57) A sheet stacking device (15) includes a sheet stacker (104), an image capturing device (110, 120), and a processing device (80). The sheet stacker (104) stacks a sheet (P). The image capturing device (110) captures an image of a whole face of the sheet (P) stacked in the sheet stacker (104). The processing device (80) detects information of the sheet (P) stacked in the sheet stacker (104) based on image data of the image captured by the image capturing device (110, 120).

FIG. 4



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Description

BACKGROUND

Technical Field

[0001] Embodiments of the present disclosure relate to a sheet stacking device and an image forming apparatus incorporating the sheet stacking device.

Background Art

[0002] Various types of sheet stacking devices are known to include a sheet stacking portion that stacks sheets.

[0003] Japanese Unexamined Patent Application Publication No. 2006-188357 (Japanese Patent No. 4324562) discloses a sheet stacking device including a detection mechanism that detects the position of a side fence functioning as a restraint that restricts the position of sheets stacked in a sheet stacking portion, so that the size of the sheets stacked on the sheet stacking portion is detected based on the position of the side fence detected by the detection mechanism.

[0004] However, the detection mechanism included in the sheet stacking device was likely to fail to detect the sheet size accurately.

SUMMARY

[0005] In view of the above-described disadvantages, an object of the present disclosure is to provide a sheet stacking device that detects the sheet size accurately and an image forming apparatus incorporating the sheet stacking device.

[0006] Embodiments of the present disclosure described herein provide a novel sheet stacking device including a sheet stacker, an image capturing device, and a processing device. The sheet stacker stacks a sheet. The image capturing device captures an image of a whole face of the sheet stacked in the sheet stacker. The processing device detects information of the sheet stacked in the sheet stacker based on image data of the image captured by the image capturing device.

[0007] Further, embodiments of the present disclosure described herein provide an image forming apparatus including the above-described sheet stacking device and an image forming device to form an image on the sheet fed from the sheet stacking device.

[0008] According to the present disclosure, a sheet stacking device and an image forming apparatus incorporating the sheet stacking device are provided to detect the sheet size accurately.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0009] Exemplary embodiments of this disclosure will be described in detail based on the following figures, wherein:

FIG. 1 is a cross-sectional view of a schematic configuration of a full-color printer as an example of an image forming apparatus including a sheet reversing device according to an embodiment of the present disclosure;
FIG. 2 is a diagram illustrating sheet conveyance paths along which a sheet travels in the image forming apparatus of FIG. 1;
FIG. 3 is a schematic perspective view of a sheet tray functioning as a sheet stacking device;
FIG. 4 is a diagram illustrating a schematic configuration of an image capturing device that captures an image of the inside of the sheet tray;
FIG. 5 is a diagram illustrating a schematic configuration of a bypass tray functioning as a sheet stacking device including an image capturing device that captures an image of the bypass tray;
FIG. 6 is a block diagram illustrating a controller that executes a given process based on information such as sheet information and sheet set information, acquired based on image data captured by the image capturing device;
FIG. 7 is a flowchart of control of sheet size detection;
FIG. 8 is a diagram illustrating the sheet tray with a large sheet stacking amount;
FIG. 9 is a diagram illustrating the sheet tray with a small sheet stacking amount;
FIG. 10 is a flowchart of control of sheet stacking amount detection;
FIG. 11 is a diagram illustrating the sheet tray when a sheet is set with an image formed face on which an image is formed being as a front face;
FIG. 12 is a flowchart of control of the front image detection of the front face of the sheet;
FIG. 13 is a diagram illustrating the sheet tray for explaining detection of presence or absence of a gap between a sheet and a side fence or a gap between a sheet and an end fence, by a processing device;
FIG. 14 is a flowchart of control of sheet-fence gap detection between a sheet and each fence;
FIG. 15 is a diagram illustrating the sheet tray for explaining last sheet detection; and
FIG. 16 is a flowchart of control of last sheet detection.

[0010] The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted.

DETAILED DESCRIPTION

[0011] It will be understood that if an element or layer is referred to as being "on," "against," "connected to" or

"coupled to" another element or layer, then it can be directly on, against, connected or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, if an element is referred to as being "directly on," "directly connected to" or "directly coupled to" another element or layer, then there are no intervening elements or layers present. Like numbers referred to like elements throughout. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0012] Spatially relative terms, such as "beneath," "below," "lower," "above," "upper" and the like may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements describes as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, term such as "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors herein interpreted accordingly.

[0013] The terminology used herein is for describing particular embodiments and examples and is not intended to be limiting of exemplary embodiments of this disclosure. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "includes" and/or "including," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0014] Referring now to the drawings, embodiments of the present disclosure are described below. In the drawings for explaining the following embodiments, the same reference codes are allocated to elements (members or components) having the same function or shape and redundant descriptions thereof are omitted below.

[0015] Next, a description is given of a configuration and functions of a sheet stacking device and an image forming apparatus incorporating the sheet stacking device, according to an embodiment of the present disclosure, with reference to drawings. Note that identical parts or equivalents are given identical reference numerals and redundant descriptions are summarized or omitted accordingly.

[0016] Now, descriptions are given of a sheet stacking device and an image forming apparatus, according to embodiments of the present disclosure, with reference to the accompanying drawings.

[0017] FIG. 1 is a cross-sectional view of a schematic configuration of a full-color printer as an example of an image forming apparatus including a sheet reversing device according to an embodiment of the present disclosure. The full-color printer is hereinafter referred to as an "image forming apparatus".

[0018] The image forming apparatus 100 illustrated in FIG. 1 includes an intermediate transfer belt 11 and four image forming devices 10M, 10C, 10Y, and 10K. The intermediate transfer belt 11 is wound around a plurality of rollers and disposed at a substantially center of a housing 50 of the image forming apparatus 100. The image forming devices 10M, 10C, 10Y, and 10K are disposed along a lower moving side of the intermediate transfer belt 11.

[0019] The image forming devices 10M, 10C, 10Y, and 10K include photoconductor drums 1M, 1C, 1Y, and 1K, respectively. Each of the photoconductor drums 1M, 1C, 1Y, and 1K functions as an image bearer. A charger, a developing device, and a cleaning device are disposed around each of the photoconductor drums 1M, 1C, 1Y, and 1K. Further, primary transfer rollers 12M, 12C, 12Y, and 12K, each functioning as a primary transfer body, are disposed at respective positions facing the photoconductor drums 1M, 1C, 1Y, and 1K, respectively, on the inner face of the intermediate transfer belt 11.

[0020] The image forming apparatus 100 according to the present embodiment includes the four image forming devices 10M, 10C, 10Y, and 10K having substantially the same structure, except that the developing devices of the respective image forming devices 10M, 10C, 10Y, and 10K contain developers having different colors, i.e., magenta, cyan, yellow, and black. The four image forming devices 10M, 10C, 10Y, and 10K are disposed in the order of colors of magenta, cyan, yellow, and black from the left in the drawing. Each of the image forming devices 10M, 10C, 10Y, and 10K functions as a process cartridge and is detachably attached to the housing 50 of the image forming apparatus 100.

[0021] An optical writing device 14 is disposed below the image forming devices 10M, 10C, 10Y, and 10K. The optical writing device 14 includes, e.g., a polygon mirror and a mirror group to irradiate, with a modulated laser beam, the surface of the photoconductor drum 1 (i.e., the photoconductor drums 1M, 1C, 1Y, and 1) of each of the image forming devices 10M, 10C, 10Y, and 10K. Although the optical writing device 14 may be provided separately for each of the image forming devices 10M, 10C, 10Y, and 10K, the use of a common optical writing device is more cost-effective. Note that the intermediate transfer belt 11 and the optical writing device 14 in the image forming apparatus 100 are also unitized. Each unit, i.e., the intermediate transfer belt 11 and the optical writing device 14, is detachably attached to the housing 50 of the image forming apparatus 100.

[0022] A sheet tray 15 that functions as a sheet stacking device is set in a lower portion of the housing 50 of the image forming apparatus 100. The sheet tray 15 includes a sheet feeder 16 for each sheet tray. The sheet

feeder 16 includes a pickup roller, a feed roller, and a separation roller. A conveyance roller pair 17 is disposed downstream from the sheet feeder 16 in the conveyance direction of a sheet P that functions as a transfer sheet so as to convey the sheet P fed by the sheet feeder 16. A registration roller pair 18 is disposed above the conveyance roller pair 17 in FIG. 1, downstream from the conveyance roller pair 17 in the conveyance direction of the sheet P. The conveyance direction of the sheet may be referred to as a sheet conveyance direction in the following descriptions. A secondary transfer roller 19 that functions as a secondary transfer body is disposed above the registration roller pair 18. The secondary transfer roller 19 is disposed facing a transfer counter roller 13 that is one of a plurality of rollers around which the intermediate transfer belt 11 is wound, to form a secondary transfer portion (secondary transfer nip region).

[0023] A fixing device 20 is disposed above the secondary transfer portion. Further, a first switching claw 21, a second switching claw 22, and a third switching claw 23 are disposed above the fixing device 20 to switch the sheet conveyance direction. Each of the first switching claw 21, the second switching claw 22, and the third switching claw 23 is driven by an actuator such as a solenoid to switch the sheet conveyance direction. Conveyance roller pairs 24, 25, 26, and 27 are appropriately disposed in respective sheet conveyance passages in the image forming apparatus 100. Sheet sensors 36, 37, 38, 39, 40, and 41 are appropriately disposed in the sheet conveyance passages.

[0024] A top face of the housing 50 functions a sheet ejection tray 30, and a sheet ejection roller pair 29 that ejects the sheet P to the sheet ejection tray 30 is disposed at an upper left position from the fixing device 20.

[0025] A switchback conveyance passage 61 and a sheet refeeding passage 62 are provided in a duplex device 60 that functions as a sheet reversing device that reverses the front and back faces of the sheet P. A first reverse roller pair 31 is disposed at an inlet portion of the switchback conveyance passage 61 (i.e., the upper side of the housing 50). A second reverse roller pair 32 is disposed downstream from the first reverse roller pair 31 in the sheet conveyance direction in the switchback conveyance passage 61. The first reverse roller pair 31 and the second reverse roller pair 32 are rotatable in forward and reverse directions. The conveyance roller pairs 26 and 27 are disposed so as to substantially equally dividing the sheet refeeding passage 62 in the duplex device 60 into three. The third switching claw 23 is disposed at a position immediately adjacent to the first reverse roller pair 31 and at an inlet portion from the switchback conveyance passage 61 to the sheet refeeding passage 62. The duplex device 60 opens and closes by rotating about a rotary shaft 63.

[0026] A bypass tray 33 that functions as a sheet stacking device is removably installed on a side face of the duplex device 60. FIG. 1 depicts that the bypass tray 33 is pulled out from the housing 50 of the image forming apparatus 100. To feed the sheet P from the bypass tray 33, a sheet feeder 34 is disposed downstream from the bypass tray 33 in the sheet conveyance direction. The sheet feeder 34 includes a pickup roller, a supply roller, and a separation roller. A sheet refeeding roller 28 is disposed near the sheet feeder 34 inside the housing 50 of the image forming apparatus 100. A driven roller is pressed against the upper part of the sheet refeeding roller 28 and another driven roller is pressed against the lower part of the sheet refeeding roller 28. The sheet refeeding roller 28 is rotatable in forward and reverse directions. The sheet refeeding roller 28 is driven to rotate counterclockwise in FIG. 1 as the sheet P is fed again from the sheet refeeding passage 62 and is driven to rotate clockwise in FIG. 1 as the sheet P is fed from the bypass tray 33.

[0027] A description is given of a basic image forming operation in the image forming apparatus 100 configured as described above.

[0028] As a drive unit rotates the photoconductor drums 1M, 1C, 1Y, and 1K of the image forming devices 10M, 10C, 10Y, and 10K clockwise in FIG. 1, the respective chargers uniformly charge the surfaces of the photoconductor drums 1M, 1C, 1Y, and 1K to a predetermined polarity. Then, the optical writing device 14 irradiates respective laser beams to the charged surfaces of the photoconductor drums 1M, 1C, 1Y, and 1K. By so doing, respective electrostatic latent images are formed on the surfaces of the photoconductor drums 1M, 1C, 1Y, and 1K. The image information used to expose the surfaces of the photoconductor drums 1M, 1C, 1Y, and 1K is monochrome image information produced by decomposing a desired full color image into magenta, cyan, yellow, and black image data. Respective color toners are applied from the developing devices to the electrostatic latent images formed in this manner to develop the electrostatic latent images into respective visible toner images.

[0029] Further, the intermediate transfer belt 11 is driven to travel counterclockwise in FIG. 1 as indicated by an arrow, and the toner images of the respective colors are sequentially superimposed and transferred from the photoconductor drums 1M, 1C, 1Y, and 1K to the intermediate transfer belt 11 due to the operation of the primary transfer rollers 12M, 12C, 12Y, and 12K in the respective image forming devices 10M, 10C, 10Y, and 10K. Thus, a full-color toner image is formed on the surface of the intermediate transfer belt 11.

[0030] In addition to the above-described image forming operation, the image forming apparatus 100 is capable of forming a single-color image by any one of the image forming devices 10M, 10C, 10Y, and 10K or forming a composite color image of two or three colors by two or three of the image forming devices 10M, 10C, 10Y, and 10K. In the printing of monochrome images, image formation is performed using the rightmost image forming device 10K in FIG. 1 among the four image forming devices 10M, 10C, 10Y, and 10K.

[0031] Residual toner remaining on the surface of the photoconductor drums 1M, 1C, 1Y, and 1K after transfer of the toner image is removed from the surface of the photoconductor drums 1M, 1C, 1Y, and 1K by the respective cleaning devices. Then, due to the operation of respective electrostatic eliminators, the surface potential of each of the photoconductor drums 1M, 1C, 1Y, and 1K is initialized to prepare for the subsequent image formation.

[0032] The registration roller pair 18 sends out a sheet selectively fed from the sheet tray 15 or the bypass tray 33, toward a secondary transfer position so that the sheet meets a toner image borne on the intermediate transfer belt 11 at the secondary transfer area. A transfer voltage having an opposite polarity to a toner charge polarity of a toner image on the surface of the intermediate transfer belt 11 is applied to the secondary transfer roller 19. By so doing, the toner image formed on the surface of the intermediate transfer belt 11 is collectively transferred onto the sheet. As the sheet P bearing the toner image passes through the fixing device 20, the toner image is fused and fixed onto the sheet by application of heat and pressure. The sheet ejection roller pair 29 ejects the sheet P bearing the fixed toner image to the sheet ejection tray 30 provided on the top face of the housing 50 of the image forming apparatus 100.

[0033] FIG. 2 is a diagram illustrating sheet conveyance paths along which a sheet P travels in the image forming apparatus 100.

[0034] A solid line PA1 in FIG. 2 indicates a sheet conveyance path along which the sheet P travels in the single-sided printing used in a case where the sheet is fed from the sheet tray 15.

[0035] A broken line PA2 in FIG. 2 indicates a sheet conveyance path along which the sheet P travels in a case where the sheet P is to be ejected to an optional tray after passing through the fixing device 20. The image forming apparatus 100 may further include an optional sheet ejection tray on another top face of the housing 50 of the image forming apparatus 100 above the second switching claw 22. The optional sheet ejection tray may be, for example, a 4bin tray having a sorting function. The broken line PA2 in FIG. 2 indicates the sheet conveyance path to which a sheet P having a fixed image is conveyed to be ejected to the optional sheet ejection tray.

[0036] A broken line PA3 in FIG. 2 is a sheet conveyance path along which the sheet P is to be conveyed into the switchback conveyance passage 61. In a case where duplex printing is executed, the first switching claw 21, the second switching claw 22, and the third switching claw 23 are appropriately switched to convey the sheet P having the fixed toner image on one side to the switchback conveyance passage 61. The first switching claw 21 and the second switching claw 22 in this case are switched to the positions to the virtual line in FIG. 2. The third switching claw 23 is switched to the position to the solid line in FIG. 2. In addition, the first reverse roller pair 31 and the second reverse roller pair 32 are rotated in the forward direction (clockwise in FIG. 1).

[0037] As the sheet sensor 40 detects the trailing end of the sheet P that is entered into the switchback conveyance passage 61, the first reverse roller pair 31 and the second reverse roller pair 32 are rotated in the reverse (opposite) direction (counterclockwise in FIG. 1) to reverse the face of the sheet P. At this time, by switching the third switching claw 23 to the position to the virtual line in FIG. 2, the sheet P reversed as described above is conveyed into the sheet refeeding passage 62.

[0038] A broken line PA4 in FIG. 2 indicates a sheet conveyance path along which the sheet P travels in the sheet refeeding passage 62. Note that this sheet conveyance path extends from the third switching claw 23 to the point at which the sheet conveyance path meets the solid line PA1.

[0039] The lower end of the sheet refeeding passage 62 meets the sheet conveyance passage extending from the bypass tray 33 and also meets the sheet conveyance passage extending from the sheet tray 15 on the inner side of the housing 50, that is, on the left side of the sheet refeeding roller 28 in FIG. 2.

[0040] The sheet P is conveyed through the sheet refeeding passage 62 by the conveyance roller pairs 26 and 27 and the sheet refeeding roller 28 to reach the registration roller pair 18.

[0041] After the face of the sheet P is reversed in the switchback conveyance passage 61, the sheet P is conveyed in the sheet refeeding passage 62. By so doing, the front face of the sheet P is reversed to the back face, a toner image is transferred onto the back face of the sheet P from the intermediate transfer belt 11, and the toner image on the back face of the sheet P is fixed to the sheet P by the fixing device 20. Then, the sheet P bearing images on the front and back faces is selectively ejected to the sheet ejection tray 30 or an optional tray via the sheet conveyance path (broken line PA2). By ejecting the sheet P to the optional tray, the duplex printing is completed.

[0042] In addition, a broken line PA5 in FIG. 2 indicates a sheet conveyance path along which the sheet P is fed from the bypass tray 33. Note that this sheet conveyance path extends to a point at which the sheet P passes through the sheet refeeding roller 28, in other words, to a point immediately downstream from the sheet refeeding roller 28 in the sheet conveyance direction.

[0043] FIG. 3 is a schematic perspective view of the sheet tray 15 functioning as a sheet stacking device.

[0044] The sheet tray 15 includes a tray housing 101 functioning as a housing of the sheet tray 15 that contains a sheet P or sheets P. The tray housing 101 includes two side fences 102 each functioning as a restraint, an end fence 103 functioning as a restraint, and a bottom plate 104 functioning as a sheet stacking portion.

[0045] The two side fences 102 are movable in the width direction of the sheet P so as to match the size of the sheet P set in the sheet tray 15. A user sets a sheet P or sheets P in the sheet tray 15 and then moves the

side fences 102 to adjust to the width of the sheets P, so that the side fences 102 contact both sides of the bundle of sheets P in the width direction. As a result, the position of the sheets P in the width direction in the tray housing 101 is restricted.

[0046] The end fence 103 is movable in the sheet conveyance direction. After the user sets a sheet P or sheets P in the sheet tray 15, the user moves the end fence 103 toward the downstream side in the sheet conveyance direction, so that the end fence 103 contacts the trailing end of the bundle of sheets P. By contacting the end fence 103 to the trailing end of the sheets P, the leading end of the sheets P is brought to contact a front wall 101a of the tray housing 101 to restrict the position of the sheets P in the sheet conveyance direction in the tray housing 101.

[0047] The bottom plate 104 is held by the tray housing 101 to be rotatable about a bottom plate rotary shaft 104a. The bottom plate 104 supports the lower face of the sheet P on the downstream end in the sheet conveyance direction (i.e., the leading end of the sheet P), so that the downstream end of the sheet P in the sheet conveyance direction moves vertically. In a case where the number (amount) of sheets P set in the sheet feeder 16 is relatively large, the downstream end of the bottom plate 104 in the conveyance direction of the sheet(s) P is lowered. By contrast, in a case where the number (amount) of the sheets P set in the sheet feeder 16 is relatively small, the downstream end of the bottom plate 104 is elevated to maintain a portion near the leading end of the upper face of the sheet(s) P being in contact with the pickup roller of the sheet feeder 16. As a result, the subsequent process may be executed on the sheet P regardless of the number of sheets P set in the sheet tray 15.

[0048] The inner face of the tray housing 101, the side fences 102, the end fence 103, and the bottom plate 104 of the sheet tray 15 have an optical difference from a sheet P in a distinguishable manner, for example, in the color, reflectance, or texture. In other words, the sheet tray 15 provides the inner face of the tray housing 101, the side fences 102, the end fence 103, and the bottom plate 104 with optical differences from the sheet P in a distinguishable manner.

[0049] FIG. 4 is a diagram illustrating a schematic configuration of an image capturing device 110 that captures an image of the inside of the sheet tray 15.

[0050] The image capturing device 110 includes an imaging unit 111 and an optical unit 112. The imaging unit 111 includes, for example, a charge coupled device (CCD) image sensor or a complementary metal oxide semiconductor (CMOS) image sensor. The optical unit 112 includes, for example, a lens and a mirror. The image capturing device 110 has an image capturing range S that covers the whole area of the sheet tray 15, as indicated by the broken lines in FIG. 4. The image capturing device 110 uses an ultra wide angle lens such as a fisheye lens as the optical unit 112 to capture the whole image inside the sheet tray 15. Further, a rotatable mirror may be used as the optical unit 112, and the whole image inside the sheet tray 15 may be captured by scanning with the mirror. The image capturing device 110 further includes an illumination unit that illuminates the inside of the sheet tray 15. The illumination unit is turned on for the image capturing device 110 to capture the image inside the sheet tray 15.

[0051] As described above, the above-described optical unit 112 of the image capturing device 110 captures an image of the whole area of the sheet P in the sheet tray 15. By so doing, a moving mechanism that moves the imaging unit 111 may be omitted. As a result, the image capturing device 110 is provided without increasing the size of the housing 50 of the image forming apparatus 100.

[0052] As described above, the sheet tray 15 provides the inner face of the tray housing 101, the side fences 102, the end fence 103, and the bottom plate 104 with optical differences from the sheet P in a distinguishable manner. As a result, the sheet P is easily recognized from the image captured by the image capturing device 110.

[0053] FIG. 5 is a diagram illustrating a schematic configuration of a bypass image capturing device 120 that captures an image of the bypass tray 33 functioning as a sheet stacking device.

[0054] As illustrated in FIG. 5, the image forming apparatus 100 further includes the bypass image capturing device 120 disposed on the right side of the housing 50 of the image forming apparatus 100 above the bypass tray 33 in the drawing. Similar to the image capturing device 110, the bypass image capturing device 120 includes an imaging unit 121 including, for example, a CCD image sensor or a CMOS image sensor, and an optical unit 122 including, for example, a lens and a mirror. The bypass image capturing device 120 also uses an ultra wide angle lens such as a fisheye lens as the optical unit 122 to have an image capturing range S that covers the whole area of the bypass tray 33, as indicated by the broken lines in FIG. 5.

[0055] Similar to the sheet tray 15, the bypass tray 33 provides a sheet stacking face functioning as a sheet stacking portion and side fences 33a with optical differences from the sheet P in a distinguishable manner, for example, in the color, reflectance, or texture. In other words, the sheet stacking face and the side fences 33a of the bypass tray 33 have an optical difference from the sheet P.

[0056] Based on image data captured by either the image capturing device 110 or the bypass image capturing device 120, sheet information and sheet setting information are acquired. The sheet information includes, for example, the sheet size of the sheet P or whether an image is formed on the sheet P set in the sheet tray 15 or the bypass tray 33. The sheet setting information includes, for example, the number of sheets P stacked in the sheet tray 15 or the bypass tray 33 or the restriction of the sheets P by the side fences and the end fence. Then, a given process is executed based on the sheet information

and the sheet setting information, based on the image data.

[0057] FIG. 6 is a block diagram illustrating a controller that executes a given process based on detection control and detection result of information such as sheet information and sheet setting information acquired based on image data captured by the image capturing device 110.

[0058] A processing device 80 illustrated in FIG. 6 processes image data of an image captured by the image capturing device 110 or the bypass image capturing device 120. The processing device 80 executes image processing such as contrast processing and trapezoidal correction on image data of the image captured by the image capturing device 110 or the bypass image capturing device 120, and then acquires the sheet information and the sheet setting information.

[0059] A memory 90 includes, for example, a hard disk drive (HDD) and a flash memory and stores information for determining whether to execute given processing based on sheet information and sheet setting information acquired from image data. The memory 90 stores, for example, sheet size data of a standard size for specifying the size of a sheet set in the sheet tray and a threshold value for determining whether a sheet is set normally.

[0060] A control panel 70 as an example of a notification device receives, as an input receiver, various inputs in response to the operation of the operator and displays messages to notify various inputs (e.g., information indicating received operation, information indicating the operation of the image forming apparatus 100, and information indicating the setting of the image forming apparatus 100).

[0061] In the present example, the control panel 70 is a liquid crystal display (LCD) having a touch panel function. However, the control panel 70 is not limited to such an LCD. Alternatively, for example, the control panel 70 may be an organic electroluminescence (EL) display having a touch panel function. In alternative to or in addition to the LCD or the EL display, the control panel 70 may include an operation device such as hardware keys and a display such as an indicator lamp. Further, the control panel 70 may include an audio station functioning as a voice notification device such as a speaker to notify users by voice.

[0062] The processing device 80 executes determination processing described in Embodiments 1 to 5 below, based on the sheet information and the sheet setting information, each being acquired as a result of the image processing, and the determination information stored in the memory 90. Based on the determination result, result information is displayed on the control panel 70 to notify the user about the result information.

[0063] Next, a detailed description is given of detection of sheet setting information and detection of sheet information based on image data of the image captured by the image capturing device 110.

Embodiment 1

[0064] Embodiment 1 is an example of detection of a sheet size as sheet information based on image data of an image captured by the image capturing device 110.

[0065] Automatic sheet size detection has been a known detection for automatically detecting the size of a sheet set in, for example, the sheet tray 15 or the bypass tray 33. Such a known automatic sheet size detection specifies the positions of the side fences 102 and the position of the end fence 103 by providing information to a sensor or a switch by, for example, a lever that moves in conjunction with movement of the side fence 102 and movement of the end fence 103. Such a known automatic sheet size detection usually a method of detecting the standard size based on the positions of the side fences 102 and the position of the end fence 103 specified by the detection.

[0066] In the method of detecting the sheet size based on the positions of the side fences 102 and the position of the end fence 103, after the user sets the sheet in the sheet tray 15 or the bypass tray 33, the side fences 102 and the end fence 103 are brought into contact with the sheet to correctly restrict the position of the sheet. By so doing, the correct sheet size is detected. For this reason, due to a user's failure of not moving the side fences 102 and the end fence 103, the side fences 102 and the end fence 103 may not contact the sheet, in other words, a gap with the sheet is relatively large, and the sheet size may be erroneously detected.

[0067] In addition, in a case where the user moves the side fences 102 and the end fence 103 to bring the side fences 102 and the end fence 103 into contact with the sheet and then returns the sheet tray 15 to the housing 50 of the image forming apparatus 100 roughly, it is likely that the side fences 102 and the end fence 103 may move due to rattling. As a result, the side fences 102 and the end fence 103 do not contact the sheet, and it is likely to cause false detection of the sheet size. If the sheet size is erroneously detected, various inconveniences such as image position error, no feeding of sheets, paper jam, skew, and wrinkles occur.

[0068] By contrast, in Embodiment 1, the sheet size is detected based on image data of an image captured by the image capturing device 110. Thus, even in a case where the side fences 102 and the end fence 103 are not in contact with the sheet due to a user's failure of not moving the side fences 102 and the end fence 103, the sheet size is detected reliably.

[0069] FIG. 7 is a flowchart of control of sheet size detection.

[0070] Note that the description of the flowchart of FIG. 7 is related to detection of the size of the sheet P set in the sheet tray 15.

[0071] The sheet tray 15 is pulled out from the housing 50 of the image forming apparatus 100 to set sheets in the sheet tray 15 (step S1). The image capturing device 110 starts capturing an image in the sheet tray 15 at a

given timing to acquire image data of the whole image inside the sheet tray 15 (steps S2 to S4). To be more specific, after the sheet is set in the sheet tray 15 in step S1, detection of the setting of the sheet tray 15 to the housing 50 of the image forming apparatus 100 is turned on, the sheet size is selected via the control panel 70, the command of sheet feeding is received, or the start button is pressed to start printing, in step S2. Then, at or after any one of the given timings in step S2, the image capturing device 110 starts capturing the image of the sheet tray 15 in step S3. Then, the image data of the image captured by the image capturing device 110 is acquired in step S4. After the image data is acquired in step S4, the processing device 80 specifies the size of the sheets set in the sheet tray 15 (step S5).

[0072] The given timing to start capturing of an image of the sheet tray 15 may be a timing at which a tray setting detection sensor that detects the setting of the sheet tray 15 to the housing 50 of the image forming apparatus 100 is changed from no detection of the setting of the sheet tray 15 to detection of the setting of the sheet tray 15. At this time, it is likely that the sheets in the sheet tray 15 have been replaced. For this reason, it is preferable that, as the tray setting detection sensor detects the change from no detection of the setting of the sheet tray 15 to detection of the setting of the sheet tray 15, the image capturing device 110 captures an image inside the sheet tray 15 to specify the size of the sheets set in the sheet tray 15. Further, the sheets in the sheet tray 15 may be replaced while the power source of the image forming apparatus 100 is turned off. For this reason, it is preferable that, even while the power source of the image forming apparatus 100 is turned on, the image capturing device 110 captures an image inside the sheet tray 15 and specifies the size of the sheets set in the sheet tray 15.

[0073] As described above, in a case where the image capturing device 110 captures the image inside the sheet tray 15 in advance before executing the printing process and specifies the size of the sheets set in the sheet tray 15, sheet size information of the sheets set in the sheet tray 15 is displayed on the control panel (step S6). Consequently, it is preferable that any size of sheets other than the size of the sheets set in the sheet tray 15 is not selected for printing.

[0074] Further, the given timing to start capturing of an image of the sheet tray 15 may also be to start printing at, for example, a timing at which a user operates the control panel 70 to select the sheet size for printing, a timing at which a command of sheet feeding is received, or a timing at which the user presses the start button on the control panel 70.

[0075] In a case where the image capturing device 110 captures an image inside the sheet tray 15 to specify the sheet size of sheets set in the sheet tray 15 at the start of starting printing as described above, it is determined, after the sheet size of sheets set in the sheet tray 15 is specified, whether the sheet size is different from the sheet size for printing that are selected by the user via the control panel 70. In a case where the specified sheet size of the sheets set in the sheet tray 15 is different from the sheet size for printing that are selected by the user via the control panel 70, the sheet size information of the specified sheets is displayed on the control panel 70 (step S6). Then, a message "Please set sheets of the proper size in the sheet tray" is displayed on the control panel 70 (step S7-1). On the other hand, in a case where the specified sheet size of the sheets set in the sheet tray 15 matches the set sheet size for printing, the sheet feeding is ready or is started (step S7-2).

[0076] First, the processing device 80 executes predetermined image processing on the image data of an image captured by the image capturing device 110, and then specifies the sheet set in the sheet tray 15 based on the image data. Next, the processing device 80 acquires sheet size data of the standard sizes from the memory 90. Next, the processing device 80 specifies the sheet size data of the standard size that matches the sheet data obtained by the image data, based on the sheet size data of the standard sizes obtained from the memory 90. Then, the processing device 80 specifies the sheet size (standard size) of the sheets set in the sheet tray 15 based on the sheet size data specified by the processing device 80.

[0077] The sheet size data of the standard sizes stored in the memory 90 may be image data of the image captured by setting the sheets of the standard size in the sheet tray 15 in advance, for example.

[0078] Since the image capturing device 110 captures the whole image inside the sheet tray 15, the whole area of the sheets set in the sheet tray is captured. As a result, the width of a sheet and the length of the sheet in the sheet conveyance direction are detected accurately, and the sheet size is detected accurately.

[0079] Further, as described above, the sheet tray 15 provides the inner face of the tray housing 101, the side fences 102, the end fence 103, and the bottom plate 104 with optical differences from the sheet P. Due to this configuration, the boundary of the sheet and the components of the sheet tray 15 is accurately determined based on the image data of the image captured by the image capturing device 110, and good sheet is detected well based on the image data.

[0080] For example, a reference mark that functions as a measurement reference at a given position of the tray housing 101 is provided to accurately specify the size of the sheet set in the sheet tray 15 and compare the standard sheet size stored in advance in the memory 90 with the sheet size data. With such a reference mark, it is preferable that the sheet size is specified accurately. The reference mark may be a seal type mark to be attached to the tray housing 101 or may be printed directly to the tray housing 101. The reference mark also may be carved in the tray housing 101.

[0081] The given timing to start capturing of an image of the bypass tray 33 may be a timing at which a sheet setting detection sensor that detects the setting of the

sheet in the bypass tray 33 detects the setting of the sheet. Further, similar to the sheet tray 15, the bypass image capturing device 120 may start capturing an image of the bypass tray 33 at the start of printing, for example, at a timing at which a user operates the control panel 70 to select the sheet size for printing, a timing at which a command of sheet feeding is received, or a timing at which the user presses the start button on the control panel 70.

Embodiment 2

[0082] Embodiment 2 is an example of detection of a sheet stacking amount of the sheets as sheet setting information, based on image data of an image captured by the image capturing device 110.

[0083] A mark 105 (see FIG. 8) that indicates the stacking upper limit position of sheets is provided on the side fences 102. However, some users set sheets on or above the stacking upper limit position, which is likely to cause the excessive stacking of sheets. While the excessive stacking amount of sheets is set in the sheet tray 15, elevation of the bottom plate 104 is not performed properly, resulting in false detection as tray abnormality. As a result, it is likely that a service call causes the image forming apparatus not to be operated temporarily.

[0084] By contrast, the sheet stacking amount is detected based on image data of the image captured by the image capturing device 110 in Embodiment 2. Due to this detection, while the excessive stacking amount of sheets is stacked or while no sheet is stacked in the sheet tray, a message is displayed on the control panel 70 to prompt a user to reset the sheets. Further, in a case where the bottom plate 104 is not properly elevated, the processing device 80 detects whether the excessive stacking amount of sheets is stacked in the sheet tray based on image data of the image captured by the image capturing device 110. When it is determined that the excessive stacking amount of sheets is stacked in the sheet tray, it is determined that the condition of the sheet tray is not abnormal. As a result, occurrence of the downtime of the image forming apparatus 100 due to the false detection as tray abnormality is prevented.

[0085] FIG. 8 is a diagram illustrating the sheet tray 15 with a large sheet stacking amount.

[0086] FIG. 9 is a diagram illustrating the sheet tray 15 with a small sheet stacking amount.

[0087] As illustrated in FIGS. 8 and 9, the detection mark 106 that is used for detecting the sheet stacking amount is formed on the leading end in the sheet conveyance direction of one of the two side fences 102 in Embodiment 2. This detection mark 106 is easily distinguishable from the sheet and the components of the sheet tray such as the side fences, according to image data of the captured image.

[0088] As illustrated in FIG. 8, in a case where the number of stacked sheets in the sheet tray 15 is relatively large, the area of the detection mark 106 that is covered by the sheets stacked on the sheet tray 15 is relatively large, and the exposed area of the detection mark 106 is relatively small. By contrast, as illustrated in FIG. 9, as the number of stacked sheets in the sheet tray 15 is decreased, the area of the detection mark 106 that is covered by the sheets stacked on the sheet tray 15 is decreased, and the exposed area of the detection mark 106 is increased.

[0089] In Embodiment 2, the exposed area of the detection mark 106 is calculated based on image data of the captured image, and then the sheet stacking amount is calculated based on the calculated exposed area of the detection mark 106. For example, in a case where the exposed area is less than the threshold value, it is determined that the excessive stacking amount of sheets is stacked in the sheet tray, so that resetting of the sheet is prompted. Further, the relation of the sheet stacking amount and the exposed area of the detection mark 106 is checked in advance, so as to specify the sheet stacking amount based on the calculated exposed area of the detection mark 106.

[0090] Note that the detection mark 106 is provided on the leading end of one of the side fences 102 in the sheet conveyance direction in FIGS. 8 and 9. However, the detection mark 106 may be provided on the trailing end in the sheet conveyance direction of one of the side fences 102 in the sheet conveyance direction. Alternatively, the detection mark 106 may be provided on the end fence 103. For example, a reference mark that functions as a reference of height may be used to detect the sheet stacking amount based on the reference mark and the distance from the top of the sheets stacked in the sheet tray 15. Since the height on the leading end of the top of the sheets stacked in the sheet tray 15 is maintained at the constant height by the bottom plate 104, the sheet stacking amount is detected based on the distance between the trailing end of the sheets stacked in the sheet tray 15 and the reference mark.

[0091] FIG. 10 is a flowchart of control of sheet stacking amount detection.

[0092] Similar to the control of sheet size detection, in the control of sheet stacking amount detection, the sheet tray 15 is pulled out from the housing 50 of the image forming apparatus 100 to set sheets in the sheet tray 15 (step S11), and then the image capturing device 110 starts capturing an image in the sheet tray 15 at a given timing to acquire image data of the whole image inside the sheet tray 15 (steps S12 to S14). To be more specific, after the sheet is set in the sheet tray 15 in step S11, detection of the setting of the sheet tray 15 to the housing 50 of the image forming apparatus 100 is turned on, the sheet size is selected via the control panel 70, the command of sheet feeding is received, or the start button is pressed to start printing, in step S12. Then, at or after any one of the given timings in step S12, the image capturing device 110 starts capturing the image of the sheet tray 15 in step S13. Then, the image data of the image captured by the image capturing device 110 is acquired

in step S14. After the image data is acquired in step S14, the processing device 80 detects the sheet stacking amount of the sheets set in the sheet tray 15 (step S15).

[0093] As the tray setting detection sensor that detects the setting of the sheet tray 15 to the housing 50 of the image forming apparatus 100 is changed from no detection of the setting of the sheet tray 15 to detection of the setting of the sheet tray 15, sheets may be added in the sheet tray 15 or sheets in the sheet tray 15 may be replaced. As a result, the sheet stacking amount in the sheet tray 15 may be changed. For this reason, it is preferable that, as the tray setting detection sensor detects the change from no detection of the setting of the sheet tray 15 to detection of the setting of the sheet tray 15, it is preferable that the image capturing device 110 captures an image inside the sheet tray 15 and the processing device 80 detects the sheet stacking amount of the sheets set in the sheet tray 15. Further, the sheets in the sheet tray 15 may be replaced while the power source of the image forming apparatus 100 is turned off. For this reason, even while the power source of the image forming apparatus 100 is turned on, it is preferable that the image capturing device 110 captures an image inside the sheet tray 15 and the processing device 80 detects the size of the sheets set in the sheet tray 15.

[0094] By detecting the sheet stacking amount at the setting of the sheet tray 15 to the housing 50 of the image forming apparatus 100 or at the power on of the power source, while the excessive stacking amount of sheets is stacked in the sheet tray 15, a message indicating that the excessive stacking amount of sheets is stacked in the sheet tray 15 is displayed on the control panel 70 to prompt the user to reset the sheets (step S17-1). Further, in a case where no sheet is set in the sheet tray 15 due to a user' s failure of not setting sheets in the sheet tray 15, a message indicating that no sheet is set in the sheet tray 15 is displayed on the control panel 70 to prompt the user to set the sheets (step S17-1).

[0095] Detection of the sheet stacking amount based on image data of the image captured by the image capturing device 110 is performed as follows. First, the processing device 80 executes predetermined image processing on the image data of an image captured by the image capturing device 110, and then specifies the detection mark 106. Then, the processing device 80 calculates the area of the specified detection mark 106. Next, the processing device 80 reads out the threshold value from the memory 90 to determine whether the excessive stacking amount of sheets is stacked in the sheet tray 15. In a case where the area of the calculated detection mark 106 is less than the threshold value, the processing device 80 determines that the excessive stacking amount of sheets is stacked in the sheet tray 15. In a case where the processing device 80 determines that the excessive stacking amount of sheets is stacked in the sheet tray 15, the message indicating that the excessive stacking amount of sheets is stacked in the sheet tray 15 on the control panel 70 to prompt the user to reduce the number of sheets and reset the sheets in the sheet tray 15, as indicated in step S17-1 of the flowchart in FIG. 10.

[0096] Further, in a case where the sheet is not detected based on the image data, the processing device 80 determines that no sheet is set in the sheet tray 15 and causes the control panel 70 to display a message indicating no sheet is set in the sheet tray 15 to prompt the user to set sheets (step S17-1).

[0097] When the processing device 80 detects the sheet based on the image data and determines that the area of the calculated detection mark 106 is equal to or greater than the threshold value, the processing device 80 reads out the data indicating the relation of the number of stacked sheets and the area of the detection mark 106, from the memory 90. Then, the processing device 80 specifies the number of stacked sheets based on the area of the calculated detection mark 106 and the data indicating the relation of the number of stacked sheets and the area of the detection mark 106 and displays the number of stacked sheets specified by the processing device 80 as the remaining amount of sheets, on the control panel (step S16). When the remaining amount of sheets is detected, the sheet feeding is ready (step S17-2). Note that detection of the number of stacked sheets based on the image data is performed at the power on or as the sheet tray 15 is set to the housing 50 of the image forming apparatus 100. Thereafter, the number of stacked sheets is reduced in accordance with the number of printed sheets. Further, the remaining amount of sheets may be roughly displayed, for example, the remaining amount of sheets: xx %, on the control panel 70.

[0098] Further, each time the printing is completed, or each time a given number of sheets is printed, the processing device 80 may cause the image capturing device 110 to capture an image, then calculate the area of the detection mark 106, and specify the number of stacked sheets. Further, in a case where the remaining amount of sheets is equal to or smaller than the given value, the processing device 80 may cause the image capturing device 110 to start capturing an image after the sheet is fed, in other words, after the trailing end of the sheet is out of the sheet tray 15 and detect whether there is a sheet or sheets based on the image data.

[0099] As described above, by displaying the remaining amount of sheets on the control panel 70, the user is prompted to replenish sheets in the sheet tray 15 at the timing the remaining amount of sheets is running short based on the remaining amount of sheets displayed on the control panel 70. As a result, occurrence of no sheet in the sheet tray 15 is prevented. Further, as the remaining amount of sheets in the sheet tray runs short, the user prepares new sheets to be set in the sheet tray. By so doing, when the sheets in the sheet tray run out, occurrence of the downtime of the image forming apparatus 100 due to no sheet being ready to be replenished is prevented.

Embodiment 3

[0100] Embodiment 3 presents an example of detection of whether an image is formed on the image forming face (front face) of a sheet, as sheet information, based on the image data of the image captured by the image capturing device 110.

[0101] FIG. 11 is a diagram illustrating the sheet tray 15 when a sheet is set with an image formed face on which an image is formed being as a front face.

[0102] From the current viewpoint of recycling and energy saving, use of the back of a sheet (reuse of a sheet having an image printed on one side or the front of the sheet) is widely spreading. In the use of the back of a sheet, however, the front and back of the sheet may be wrongly placed by setting the image formed face as the front of the sheet, as illustrated in FIG. 11. In this case, a new image to be printed is overlapped on the image that has already been printed on the front of the sheet ("R" in FIG. 11). As a result, a desired image is not obtained.

[0103] Some typical sheet trays include a mechanism disposed upstream from the registration roller pair 18 in the sheet conveyance direction to determine whether an image is formed on the front face of a sheet. When such a typical mechanism determines that an image is formed on the front face of a sheet, image formation of the image has already been started. For this reason, the toner image formed on the sheet is discarded (by forced cleaning), resulting in a waste of toner.

[0104] On the other hand, in Embodiment 3, whether an image is formed on the front face of the sheet is determined when sheets are set in the sheet tray 15 or the bypass tray 33. As a result, whether an image is formed on the front face of the sheet is determined before starting the image formation, and the wasteful consumption of toner is prevented.

[0105] FIG. 12 is a flowchart of control of the front image detection of the front face of the sheet.

[0106] Similar to the sheet size detection, in the front image detection, the sheet tray 15 is pulled out from the housing 50 of the image forming apparatus 100 to set sheets in the sheet tray 15 (step S21), and then the image capturing device 110 starts capturing an image in the sheet tray 15 at a given timing to acquire image data of the whole image inside the sheet tray 15 (steps S22 to S24). To be more specific, after the sheet is set in the sheet tray 15 in step S21, detection of the setting of the sheet tray 15 to the housing 50 of the image forming apparatus 100 is turned on, the sheet size is selected via the control panel 70, the command of sheet feeding is received, or the start button is pressed to start printing, in step S22. Then, at or after any one of the given timings in step S22, the image capturing device 110 starts capturing the image of the sheet tray 15 in step S23. Then, the image data of the image captured by the image capturing device 110 is acquired in step S24. After the image data is acquired in step S24, the processing device 80 detects whether an image is formed on the front face of the sheet set in the sheet tray 15 (step S25-1, step S25-2).

[0107] As the tray setting detection sensor that detects the setting of the sheet tray 15 to the housing 50 of the image forming apparatus 100 is changed from no detection of the setting of the sheet tray 15 to detection of the setting of the sheet tray 15, the sheet or sheets in the sheet tray 15 may be replaced to the back face that is the opposite face of the image formed face of the sheet. For this reason, as the tray setting detection sensor detects the change from no detection of the setting of the sheet tray 15 to detection of the setting of the sheet tray 15, the image capturing device 110 captures an image inside the sheet tray 15 to detect whether an image is formed on the front face of the sheets set in the sheet tray 15. Further, it is likely that, at the timing the power source of the image forming apparatus 100 is turned off, the sheets in the sheet tray 15 are replaced to print an image on the back face of the sheets. For this reason, even at the time of turning on the power source of the image forming apparatus 100, the processing device 80 causes the image capturing device 110 to capture an image inside the sheet tray 15 to detect whether an image is formed on the front face of a sheet set in the sheet tray.

[0108] Note that the image capturing device 110 may start image capturing for detecting whether any image is formed on the front face of the sheet, at any timing before the start of image formation. For example, the image capturing device 110 may start image capturing at any timing other than the timing described in step S22 in the flowchart of FIG. 12.

[0109] Detection of whether any image is formed on the front face of the sheet based on the image data of the image captured by the image capturing device 110 is performed by the processing device 80 by confirming whether any image having the color other than the color of the sheet (white) is formed in the detection range of the sheet in the image data of the image captured by the image capturing device 110. In a case where the image including a color other than the color of the sheet (white) is formed on the front face of the sheet, the processing device 80 determines that an image is formed on the front face of the sheet.

[0110] For example, in a case where the image including the color of the sheet (white) is not detected in the detection range of the sheet, the processing device 80 determines that no image is formed on the front face of the sheet. On the other hand, in a case where the image including the color of the sheet (white) and the image including the color other than the color of the sheet (white) are detected in the detection range of the sheet, the processing device 80 may determine that an image is formed on the front face of the sheet.

[0111] In a case where the processing device 80 determines that an image is not formed on the front face of the sheet (step S25-2), it is determined that the sheet feeding is ready (step S26-2). On the other hand, in a case where the processing device 80 determines that an

image is formed on the front face of the sheet (step S25-1), the processing device 80 causes the control panel 70 to display the message indicating that an image is formed on the front face of the sheet. Further, the processing device 80 causes the control panel 70 to display the warning message to confirm the front and back of the sheets set in the sheet tray 15 (step S26-1). Further, the processing device 80 causes the control panel 70 to display the accept button together with the warning message.

[0112] In a case where the accept button is pressed (selected) to continue the process, the sheets are ready to be fed, in other words, the sheet feeding is ready to be performed (step S27-1). On the other hand, in a case where the sheet tray is pulled out and the setting detection is turned off to set the sheets in the sheet tray 15 again (step S28-1), the warning message is cancelled. Then, as the setting detection is switched from OFF to ON, the processing device 80 causes the image capturing device 110 to capture an image inside the sheet tray again to detect whether an image is formed on the front face of the sheet.

As a result, the image to be printed this time is prevented from unintentionally overlapping the previously printed image, and wasteful consumption of toner is prevented.

[0113] In addition, in a case where the sheets set in the sheet tray are waved or curled or folded, a shadow is formed on the sheet area of the image data. The processing device 80 may determine the shadow as an image having the color other than the color of the sheet (white) in the detection area of the sheet. For this reason, it is preferable to be determined whether the image having the color other than the color of the sheet (white) is an image corresponding to waving, curling, and folding or an image formed on the front face of the sheet. For example, by learning the image corresponding to waving, curling, and folding by, for example, deep learning, the processing device 80 determines whether the image having the color other than the color of the sheet (white) is an image corresponding to waving, curling, and folding.

[0114] When waving, curling, or folding is detected in the sheet set in the sheet tray, such waving, curling, or folding has been formed in the sheet set in the sheet tray, which is likely to result in a paper jam. For this reason, when the processing device 80 detects waving, curling, or folding in the sheet, it is preferable that the condition of the sheet set in the sheet tray, i.e., waving, curling, or folding, is displayed on the control panel 70 to prompt the user to replace the sheet. As a result, occurrence of a paper jam is prevented.

Embodiment 4

[0115] Embodiment 4 presents an example of detection of whether there is a gap between the sheet and either of the side fences 102 or a gap between the sheet and the end fence 103, as sheet setting information, based on image data of an image captured by the image capturing device 110.

[0116] In a case where the position of the sheet set in the sheet tray is not restricted due to a user's failure such as omission of setting the side fences 102 or the end fence 103 properly or insufficient alignment (insufficient jogging) of the sheet by the side fences 102 or the end fence 103, it is likely to cause no sheet feeding, paper jam, sheet skew, or sheet wrinkle. It is also likely to cause image position error where an image is not formed at a target position.

[0117] On the other hand, in Embodiment 4, the processing device 80 detects whether there is a gap between the sheet and either of the side fences 102 or a gap between the sheet and the end fence 103, based on image data of an image captured by the image capturing device 110, and then determines whether the sheet is correctly restricted. As a result, when the position of the sheet set in the sheet tray is not restricted due to the user's failure such as omission of setting the side fences 102 or the end fence 103 properly or insufficient alignment (insufficient jogging) of the sheet by the side fences 102 or the end fence 103, the user is prompted to set or move the side fences 102 or the end fence 103 properly. As a result, occurrence of no sheet feeding, paper jam, sheet skew, or sheet wrinkle is prevented. Further, occurrence of image position error where an image is not formed at a target position is prevented.

[0118] FIG. 13 is a diagram illustrating the sheet tray 15 for explaining detection of whether there is a gap between a sheet and either of the side fences 102 or a gap between a sheet and the end fence 103, by a processing device 80.

[0119] The processing device 80 obtains a sheet length PL and a sheet width PW from the image data of the image captured by the image capturing device 110. Specifically, the sheet size is specified by the method described in Embodiment 1, and the sheet length PL and the sheet width PW are obtained from the specified sheet size.

[0120] Further, the processing device 80 measures the interval LS between the fences of the pair of side fences 102 based on the image data of the image captured by the image capturing device 110. It is preferable that a position detection mark that is distinguishable from the parts in the sheet tray 15 is provided for one of the side fences 102 so that the processing device 80 easily grasps the position of the side fence 102 from the image data. Then, the processing device 80 detects the gap between the side fence 102 with the position detection mark and the sheet based on the measured interval between the side fence 102 and the sheet width.

[0121] Further, the processing device 80 measures the distance LE from the front wall 101a of the tray housing 101 to the end fence 103 based on the image data of the image captured by the image capturing device 110. It is preferable that a position detection mark that is distinguishable from the parts in the sheet tray 15 is provided for the end fence 103 and the front wall 101a so that the

processing device 80 easily grasps the position of the end fence 103 and the position of the front wall 101a from the image data. Then, the processing device 80 detects the gap between the end fence 103 and the sheet from the measured distance from the front wall 101a to the end fence 103 and the length of the sheet.

[0122] FIG. 14 is a flowchart of control of sheet-fence gap detection between the sheet and each of the side fences 102 and the end fence 103.

[0123] Similar to the sheet size detection, in the sheet-fence gap detection, the sheet tray 15 is pulled out from the housing 50 of the image forming apparatus 100 to set sheets in the sheet tray 15 (step S31), and then the image capturing device 110 starts capturing an image in the sheet tray 15 at a given timing to acquire image data of the whole image inside the sheet tray 15 (steps S32 to S34). To be more specific, after the sheet is set in the sheet tray 15 in step S31, detection of the setting of the sheet tray 15 to the housing 50 of the image forming apparatus 100 is turned on, the sheet size is selected via the control panel 70, the command of sheet feeding is received, or the start button is pressed to start printing, in step S32. Then, at or after any one of the given timings in step S32, the image capturing device 110 starts capturing the image of the sheet tray 15 in step S33. Then, the image data of the image captured by the image capturing device 110 is acquired in step S34. Further, the processing device 80 specifies the sheet size and measures the interval LS of the side fences 102 and the distance LE from the front wall 101a of the tray housing 101 to the end fence 103 based on the image data of the image captured by the image capturing device 110 (step S35).

[0124] Then, the processing device 80 calculates the difference of the sheet width obtained from the specified sheet size and the interval between the side fences 102, and then detects the gap between the sheet and the side fences 102. Then, the processing device 80 calculates the difference of the sheet length obtained from the specified sheet size and the distance LE from the front wall 101a to the end fence 103, and then detects the gap between the sheet and the end fence 103 (step S36).

[0125] Next, the processing device 80 reads out, from the memory 90, the threshold value of the gap between each fence and the sheet, and then compares the difference and the threshold value to determine whether the calculated gap of the sheet and the side fences 102 is equal to or greater than the threshold value. Further, the processing device 80 compares the difference and the threshold value to determine whether the calculated gap of the sheet and the end fence 103 is equal to or greater than the threshold value (step S37).

[0126] Then, in a case where the calculated gap of the sheet and the side fences 102 or the calculated gap of the sheet and the end fence 103 is smaller than the threshold value (step S38-2), the sheet feeding is ready (step S39-2). On the other hand, in a case where the calculated gap of the sheet and the side fences 102 or the calculated gap of the sheet and the end fence 103 is equal to or greater than the threshold value (step S38-1), the processing device 80 causes the control panel 70 to display a warning message indicating that the position of the sheet is not restricted correctly. Then, the processing device 80 causes the control panel 70 to display a message to prompt the user to confirm the end fence 103 and the side fences 102 and display the accept button (step S39-1).

[0127] As the accept button is clicked (selected), the sheets in the sheet tray 15 are ready to be fed. On the other hand, as the sheet tray 15 is pulled out form the housing 50 of the image forming apparatus 100 and the setting detection is turned off to check the position of the end fence 103 and the positions of the side fences 102 (step S40-1), the warning message is cancelled. Then, as the setting detection is switched from OFF to ON, the processing device 80 causes the image capturing device 110 to capture an image inside the sheet tray 15 again to check whether the end fence 103 and the side fences 102 restrict the position of the sheet correctly.

[0128] By so doing, the sheet is prevented from being fed unintentionally while the position of the sheet is not restricted by the end fence 103 and the side fences 102.

Embodiment 5

[0129] Embodiment 5 presents an example of detection of whether the sheet set in the sheet tray 15 is the last sheet as information of the sheet, based on image data of the image captured by the image capturing device 110.

[0130] Since the message to prompt the user to set or replenish sheets in the sheet tray 15 is typically displayed after the sheet runs out, the toner for image formation is to be discarded (forcedly cleaned) after the last sheet is printed at the continuous printing.

[0131] By contrast, the last sheet set in the sheet tray 15 is detected based on image data of the image captured by the image capturing device 110 in Embodiment 5. Due to this configuration in Embodiment 5, the image formation is temporarily stopped based on the detection result, after an image is formed on the last sheet in the continuous printing. As a result, occurrence of discarding toner for image formation (forced cleaning) after the last sheet is printed is prevented, and the wasteful consumption of toner is prevented.

[0132] FIG. 15 is a diagram illustrating the sheet tray for explaining last sheet detection.

[0133] The leading ends of several sheets from the top of the sheet bundle on the bottom plate 104 do not face the front wall 101a, and movement of the sheets toward the downstream side in the sheet conveyance direction by the front wall 101a is not restricted. The sheet feeder 16 forms a separation nip region by bringing a separation roller into contact with the supply roller at a portion downstream from the pickup roller in the sheet conveyance direction of the sheet P, separates an uppermost sheet

from a plurality of sheets conveyed by the pickup roller at the separation nip region, and conveys the uppermost sheet toward the registration roller pair. For this reason, as the uppermost sheet placed on top of the sheet bundle is fed, the subsequent sheet that is the second sheet immediately under the uppermost sheet usually moves, together with the uppermost sheet, to the sheet separation nip region due to the frictional force. Accordingly, the subsequent sheet to be fed is placed downstream from the sheet setting position in the sheet conveyance direction.

[0134] As to the last sheet (lowermost sheet), as the sheet that a second last sheet is placed on the last sheet in the sheet tray 15 is fed by the sheet feeder 16, the last sheet moves together with the second last sheet to a portion near the separation nip region, as illustrated in FIG. 15. As a result, by detecting the movement of the position of the trailing end of the sheet detected from the image data of the captured image, the processing device 80 determines whether the sheet set in the sheet tray 15 is the last sheet.

[0135] FIG. 16 is a flowchart of control of last sheet detection.

[0136] The sheet feeder 16 is driven to start feeding sheets (step S41). After a given time elapses, the processing device 80 causes the image capturing device 110 to start capturing an image of the inside of the sheet tray 15, and then acquires image data of the image of the inside of the sheet tray 15 captured by the image capturing device 110 (step S42).

[0137] Next, the processing device 80 detects the position of the trailing end of the sheet in the sheet tray 15 based on the image data of the image captured by the image capturing device 110. The processing device 80 detects the position of the trailing end of the sheet from the boundary of the image portion on the sheet (white image) of the image data and the bottom plate 104 or the colored image indicating the inner face of the tray housing 101. Then, the processing device 80 detects the position of the end fence 103 based on the image data of the image captured by the image capturing device 110. It is preferable that a position detection mark that is distinguishable from the parts in the sheet tray 15 is provided for the end fence 103 so that the processing device 80 detects the position of the end fence 103 based on the position detection mark to easily grasp the position of the end fence 103 from the position detection mark. Then, the processing device 80 measures the gap between the trailing end of the sheet and the end fence 103 based on the detected position of the trailing end of the sheet and the detected position of the end fence 103 (step S44).

[0138] Then, the processing device 80 reads out the gap of the trailing end of the sheet and the end fence 103 calculated based on the image data of the image captured by the image capturing device 110 at the setting of the sheet that is stored in the memory 90 and the threshold value for detecting the last sheet. Then, the processing device 80 calculates the difference of the gap between the trailing end of the sheet and the end fence 103 at this time and the gap of the trailing end of the sheet and the end fence 103 at the setting of the sheet, and then measures the amount of increase of the gap between the trailing end of the sheet and the end fence 103.

[0139] In a case where three or more sheets are stacked in the sheet tray at the start of sheet feeding, the last sheet is in contact with the bottom plate 104 and the leading end of the last sheet is in contact with the front wall 101a. Due to this configuration, the movement of the last sheet in the sheet conveyance direction is restricted. For this reason, the last sheet is not moved, and the amount of increase of the gap between the trailing end of the sheet and the end fence 103 is substantially zero (0). As a result, the amount of increase at this time is equal to or less than the threshold value, and the processing device 80 determines that the sheet is not the last sheet (S45-2). Then, the processing device 80 determines that the subsequent sheet feeding is ready, in other words, the sheet in the sheet tray 15 is not the last sheet (step S46-2).

[0140] On the other hand, in a case where two sheets are stacked in the sheet tray 15 at the start of sheet feeding, the leading end of the last sheet is not in contact with the front wall 101a. Accordingly, as the sheet feeding is started, the last sheet is conveyed to the sheet separation nip region together with the second last sheet. As a result, the amount of increase of the gap with respect to the gap between the trailing end of the sheet and the end fence 103 at the time of sheet setting exceeds the threshold value. Accordingly, it is detected that the sheet set in the sheet tray 15 is the last sheet.

[0141] Note that the processing device 80 determines whether the sheet in the sheet tray is a last sheet based on the amount of increase with respect to the gap between the end fence 103 and the sheet at the time of sheet setting in the above-described embodiments. However, when the gap between the end fence 103 and the sheet exceeds the threshold value, the processing device 80 determines that the last sheet is moved and may determine that the sheet in the sheet tray 15 is the last sheet.

[0142] When the amount of increase of the gap between the trailing end of the sheet and the end fence 103 is greater than the threshold value and the processing device 80 determines that the sheet in the sheet tray 15 is the last sheet (step S45-1), the processing device 80 causes the control panel 70 to display a message indicating that no sheet is set in the sheet tray, after the last sheet is fed (step S46-1). Further, no sheet in the sheet tray may be notified by sound such as buzzer sound.

[0143] Note that, after the processing device 80 determines that the sheet set in the sheet tray 15 is the last sheet, a message indicating that the subsequent sheet is the last sheet may be displayed on the control panel 70. Such a display of the message prompts a user to prepare new sheets to be replenished before the sheet tray runs out of sheet, so that the sheet tray 15 is replenished with new sheets when or before the sheet tray runs

out of sheets.

[0144] Further, when the last sheet is detected in the continuous printing, the image forming operation for the subsequent image is temporarily stopped formed and the message indicating no sheet in the sheet tray 15 is displayed on the control panel 70. As a result, wasteful consumption of toner is prevented. In addition, occurrence of no sheet in the sheet tray 15 is notified before the last sheet is fed from the sheet tray 15. As a result, when compared with a configuration in which occurrence of no sheet in the sheet tray is notified after the last sheet is fed from the sheet tray 15, a user quickly prepares new sheets to be replenished in the sheet tray 15 to quickly restart the continuous printing.

[0145] Note that the image forming apparatus 100 may employ any one of Embodiments 1 to 5, two or more of Embodiments 1 to 5, or each of Embodiments 1 to 5. Note that, even though the sheet tray 15 is applied to Embodiments 1 to 5 described above, the bypass tray 33 may also be applied to Embodiments 1 to 5.

[0146] The above-described embodiments are limited examples, and the present disclosure includes, for example, the following modes (aspects) having advantageous effects.

Mode 1

[0147] In Mode 1, a sheet stacking device (for example, the sheet tray 15) includes a sheet stacking portion (for example, the bottom plate 104) to stack a sheet (for example, the sheet P), and an image capturing device (for example, the image capturing device 110) to capture an image of a whole face of the sheet stacked on the sheet stacking portion. A processing device (for example, the processing device 80) detects a sheet size of the sheet stacked on the sheet stacking portion based on image data of the image captured by the image capturing device.

[0148] It is likely that a user fails to correctly move the side fence or side fences in some known sheet stacking devices. Such a failure tends to cause the side fence or side fences not to be in contact with the lateral end of the sheet, and the position of the sheet may not be restricted. In addition, a gap may be formed between the side fence and the lateral end of the sheet due to structural play. In a case where the side fence is not in contact with the lateral end of the sheet, the position of the side fence does not correspond to the position of the sheet in the width direction. As a result, the sheet size information detected based on the position of the side fence may be incorrect.

[0149] On the other hand, in Mode 1, since the image capturing device captures the image of the whole face of the sheet stacked on the sheet stacking portion, the width of the sheet and the length of the sheet in the sheet conveyance direction are grasped based on the image data of the image captured by the image capturing device, and the sheet size is detected well. As a result, the sheet size is detected accurately even while the side fence is not in contact with the sheet.

Mode 2

[0150] In the sheet stacking device (for example, the sheet tray 15) of Mode 1, the processing device (for example, the processing device 80) causes the image capturing device (for example, the image capturing device 110) to capture an image of the sheets stacked on the sheet stacking portion (for example, the bottom plate 104) together with a detection mark (for example, the detection mark 106) formed on the sheet stacking device to detect a position of the sheets in a vertical direction, and detects a sheet stacking amount of the sheets stacked on the sheet stacking portion based on the image data of the image of the detection mark and the sheet stacked on the sheet stacking portion captured together by the image capturing device.

[0151] According to this configuration, as described in Embodiment 2, by capturing the image of the sheets stacked on the sheet stacking portion such as the bottom plate 104 together with the detection mark such as the detection mark 106 to detect the position of the sheets in the vertical direction, the relation of the detection mark (the detection mark 106) and the sheets stacked on the sheet stacking portion is grasped based on the image data of the image captured by the image capturing device. In Embodiment 2, the relation of detection mark and the sheets corresponds to the area of the detection mark that is not covered by the sheets and is changed depending on the height of the sheets on the sheet stacking portion. As a result, the sheet stacking amount of the sheets stacked on the sheet stacking portion is grasped based on the image data of the image captured by the image capturing device.

[0152] Then, by detecting the sheet stacking amount, while no sheet is stacked in the sheet stacker, the condition is detected. By so doing, the excessive stacking amount of sheets on the sheet stacking portion or the condition of no sheet on the sheet stacking portion is notified to prompt a user for replenishment and setting of sheets. Further, in a case where the sheet stacking portion such as the bottom plate 104 is not properly elevated, the processing device (for example, the processing device 80) determines whether the operation abnormality is caused by the sheets that are excessively stacked on the sheet stacking portion, and occurrence of the downtime of the image forming apparatus due to false detection of the operation error is prevented.

[0153] Further, the sheet size and the sheet stacking amount are detected based on the image data of the image captured by the image capturing device. When compared with the configuration where a device that detects the sheet size and another device that detects the sheet stacking amount are separately provided, the above-described configuration achieves a reduction in the number of parts and a reduction of cost of the image

forming apparatus.

Mode 3

[0154] In the sheet stacking device (for example, the sheet tray 15) of Mode 1 or Mode 2, the processing device (for example, the processing device 80) detects whether the sheet (for example, the sheet P) stacked on the sheet stacking portion (for example, the bottom plate 104) is a last sheet based on the image data of the image captured by the image capturing device (for example, the image capturing device 110).

[0155] According to this configuration, as described in Embodiment 5, the last sheet is conveyed together with the previous sheet toward the separation position such as a separation nip region. For this reason, in a case where the sheet on the sheet stacking portion is the last sheet, the position of the sheet stacked on the sheet stacking portion is located further downstream in the sheet conveyance direction than the position of the sheet that is not the last sheet. Accordingly, as the image capturing device captures the whole sheet, whether the sheet is moved further downstream in the sheet conveyance direction is grasped based on the image data of the image captured by the image capturing device. In a case where the processing device detects that the sheet is moved further downstream in the sheet conveyance direction, based on the image data of the image captured by the image capturing device, the processing device determines that the sheet stacked on the sheet stacking portion is the last sheet remaining on the sheet stacking portion.

[0156] As described above, the processing device determines whether the sheet stacked on the sheet stacking portion is the last sheet remaining on the sheet stacking portion. By so doing, in a case where the sheet stacked on the sheet stacking portion is determined as the last sheet in the continuous printing, after the last sheet is printed, the image forming operation is stopped. As a result, occurrence of discarding toner for image formation (forced cleaning) is prevented, and the wasteful consumption of toner is prevented. The condition of the sheet being running short is notified to a user before the last sheet is fed from the sheet stacking portion. As a result, when compared with a configuration having no sheet in the sheet tray is notified to a user after the last sheet is fed from the sheet tray, the downtime of the device or apparatus is reduced.

[0157] Further, detection of whether the sheet stacked on the sheet stacking portion is a last sheet and another detection (at least one of detection of the sheet size or detection of the sheet stacking amount) are performed, based on the image data of the image captured by the image capturing device. Accordingly, when compared with a configuration including a device that performs detection of whether the sheet stacked on the sheet stacking portion is a last sheet and another device that performs another detection described above, the sheet stacking device of Mode 3 achieves a reduction in the number of parts and a reduction in cost of the image forming apparatus.

Mode 4

[0158] A sheet stacking device (for example, the sheet tray 15) includes a sheet stacking portion (for example, the bottom plate 104) to stack a sheet (for example, the sheet P), and an image capturing device (for example, the image capturing device 110) to capture an image of a whole face of the sheet stacked on the sheet stacking portion. A processing device (for example, the processing device 80) detects whether the sheet stacked on the sheet stacking portion is a last sheet based on the image data of the image captured by the image capturing device.

[0159] According to this configuration, as described in Embodiment 5, the last sheet is conveyed together with the previous sheet toward the separation position such as a separation nip region. For this reason, in a case where the sheet on the sheet stacking portion is the last sheet, the position of the sheet stacked on the sheet stacking portion is located further downstream in the sheet conveyance direction than the position of the sheet that is not the last sheet. Accordingly, as the image capturing device captures the whole sheet, whether the sheet is moved further downstream in the sheet conveyance direction is grasped based on the image data of the image captured by the image capturing device. In a case where the processing device detects that the sheet is moved further downstream in the sheet conveyance direction, based on the image data of the image captured by the image capturing device, the processing device determines that the sheet stacked on the sheet stacking portion is the last sheet remaining on the sheet stacking portion.

[0160] As described above, the processing device determines whether the sheet stacked on the sheet stacking portion is the last sheet remaining on the sheet stacking portion. By so doing, in a case where the sheet stacked on the sheet stacking portion is determined as the last sheet in the continuous printing, after the last sheet is printed, the image forming operation is stopped. As a result, occurrence of discarding toner for image formation (forced cleaning) is prevented, and the wasteful consumption of toner is prevented. The condition of the sheet being running short is notified to a user before the last sheet is fed from the sheet stacking portion. As a result, when compared with a configuration having no sheet in the sheet tray is notified to a user after the last sheet is fed from the sheet tray, the downtime of the device or apparatus is reduced.

Mode 5

[0161] In the sheet stacking device (for example, the sheet tray 15) of any one of Modes 1 to 4, the processing

device (for example, the processing device 80) detects whether an image is formed on an image forming face of the sheet (for example, the front face of the sheet P) based on image data of the image captured by the image capturing device (for example, the image capturing device 110).

[0162] According to this configuration, as described in Embodiment 3, in the back face printing of an image on an opposite face that is opposite to the front face (image formed face) of the sheet and that has no image, the processing device detects that the user sets the sheet on the sheet stacking portion, with the image formed face of the sheet being as a front face of the sheet, by mistake. As a result, the image to be printed this time is prevented from unintentionally being printed on the image formed face of the sheet, and the wasteful consumption of toner is prevented.

[0163] In addition to the detection of whether an image is formed on an image formed face such as the front face of the sheet, the processing device detects at least one of the sheet size, the sheet stacking amount, or whether the sheet is the last sheet, based on the image data of the image captured by the image capturing device. As described above, multiple detections are performed based on the image data of the image captured by the image capturing device, which achieves a reduction in the number of parts when compared with a configuration in which multiple detections are performed by separate detecting devices and a reduction in cost of the image forming apparatus.

Mode 6

[0164] A sheet stacking device (for example, the sheet tray 15) includes a sheet stacking (for example, the bottom plate 104) to stack a sheet (for example, the sheet P), and an image capturing device (for example, the image capturing device 110) to capture an image of a whole face of the sheet stacked on the sheet stacking portion. The processing device (for example, the processing device 80) detects whether an image is formed on an image forming face of the sheet (for example, the front face of the sheet P) based on the image data of the image captured by the image capturing device.

[0165] According to this configuration, as described in Embodiment 3, in the back face printing of an image on an opposite face that is opposite to the front face (image formed face) of the sheet and that has no image, the processing device detects that the user sets the sheet on the sheet stacking portion, with the image formed face of the sheet being as a front face of the sheet, by mistake. As a result, the image to be printed this time is prevented from unintentionally being printed on the image formed face of the sheet, and the wasteful consumption of toner is prevented.

Mode 7

[0166] The sheet stacking device (for example, the sheet tray 15) of any one of Modes 1 to 6 further includes a restraint (for example, the side fences 102, the end fence 103) to restrict a position of the sheet (for example, the sheet P) stacked on the sheet stacking portion (for example, the bottom plate 104). The processing device (for example, the processing device 80) causes the image capturing device to simultaneously capture an image of the restraint and the sheet stacked on the sheet stacking portion by the image capturing device (for example, the image capturing device 110), and then detects a gap between the sheet stacked on the sheet stacking portion and the restraint based on image data of the image of the restraint and the sheet.

[0167] According to this configuration, as described in Embodiment 4, the processing device determines whether the position of the sheet is restricted by the restraint. As a result, in a case where the position of the sheet set in the sheet tray is not restricted due to user's omission of restricting the restraint such as the side fences or the end fence or insufficient alignment (insufficient jogging) of the sheet by the side fences 102 or the end fence 103, the operation of the restraint is prompted to the user. As a result, occurrence of no sheet feeding, paper jam, sheet skew, or sheet wrinkle is prevented. Further, occurrence of image position error where an image is not formed at a target position is prevented.

[0168] In addition to the gap between the sheet and the restraint, the processing device detects at least one of whether an image is formed on an image forming face such as the front face of the sheet, the sheet size, the sheet stacking amount, or whether the sheet is the last sheet, based on the image data of the image captured by the image capturing device. As described above, multiple detections are performed based on the image data of the image captured by the image capturing device, which achieves a reduction in the number of parts and a reduction in cost of the image forming apparatus, when compared with a configuration in which multiple detections are performed by separate detecting devices.

Mode 8

[0169] In the sheet stacking device (for example, the sheet tray 15) of Mode 1 further includes a sheet stacking portion (for example, the bottom plate 104) to stack the sheet (for example, the sheet P), a restraint (for example, the side fences 102, the end fence 103) to restrict a position of the sheet stacked on the sheet stacking portion, and an image capturing device (for example, the image capturing device 110) to simultaneously capture an image of the restraint and the sheet stacked on the sheet stacking portion. The processing device (for example, the processing device 80) detects a gap between the sheet stacked on the sheet stacking portion and the restraint based on image data of the image captured by

the image capturing device.

[0170] According to this configuration, as described in Embodiment 4, the processing device determines whether the position of the sheet is restricted by the restraint. As a result, in a case where the position of the sheet set in the sheet tray is not restricted due to user's omission of restricting the restraint such as the side fences or the end fence or insufficient alignment (insufficient jogging) of the sheet by the side fences 102 or the end fence 103, the operation of the restraint is prompted to the user. As a result, occurrence of no sheet feeding, paper jam, sheet skew, or sheet wrinkle is prevented. Further, occurrence of image position error where an image is not formed at a target position is prevented.

Mode 9

[0171] In the sheet stacking device (for example, the sheet tray 15) of any one of Modes 1 to 8, a component (for example, the tray housing 101, the side fences 102, the end fence 103, the bottom plate 104) of the sheet stacking device has reflectance properties distinctive from the sheet (for example, having an optical difference from the sheet) in the image data of the image captured by the image capturing device (for example, the image capturing device 110). According to this configuration, based on the image data of the image captured by the image capturing device, the boundary of the sheet stacked in the sheet stacking device and the component of the sheet stacking device is determined easily, and the sheet is detected accurately.

Mode 10

[0172] An image forming apparatus (for example, the image forming apparatus 100) includes the sheet stacking device (for example, the sheet tray 15) of any one of Modes 1 to 9, and an image forming device (for example, the image forming devices 10M, 10C, 10Y, 10K) to form an image on a sheet (for example, the sheet P) fed from the sheet stacking device.

[0173] Accordingly, occurrence of a defective image, paper jam, and a waste of toner consumption is prevented.

Mode 11

[0174] The image forming apparatus (for example, the image forming apparatus 100) of Mode 10 further includes a notification device (for example, the control panel 70) to notify a user of information detected based on the image data of the image captured by the image capturing device (for example, the image capturing device 110).

[0175] According to this configuration, as described in the embodiments above, the information of the sheet stacked in the sheet stacking device (for example, the sheet tray 15, the bypass tray 33) is notified to a user, so that the user is prompted to perform the notified operation.

[0176] The present disclosure is not limited to specific embodiments described above, and numerous additional modifications and variations are possible in light of the teachings within the technical scope of the appended claims. It is therefore to be understood that, the disclosure of this patent specification may be practiced otherwise by those skilled in the art than as specifically described herein, and such, modifications, alternatives are within the technical scope of the appended claims. Such embodiments and variations thereof are included in the scope and gist of the embodiments of the present disclosure and are included in the embodiments described in claims and the equivalent scope thereof.

[0177] The effects described in the embodiments of this disclosure are listed as the examples of preferable effects derived from this disclosure, and therefore are not intended to limit to the embodiments of this disclosure.

[0178] The embodiments described above are presented as an example to implement this disclosure. The embodiments described above are not intended to limit the scope of the invention. These novel embodiments can be implemented in various other forms, and various omissions, replacements, or changes can be made without departing from the gist of the invention. These embodiments and their variations are included in the scope and gist of this disclosure and are included in the scope of the invention recited in the claims and its equivalent.

[0179] Any one of the above-described operations may be performed in various other ways, for example, in an order different from the one described above.

Claims

1. A sheet stacking device (15) comprising:

a sheet stacker (104) to stack a sheet (P);
an image capturing device (110) to capture an image of a whole face of the sheet (P) stacked in the sheet stacker (104); and
a processing device (80) to detect information of the sheet (P) stacked in the sheet stacker (104) based on image data of the image captured by the image capturing device (110, 120).

2. The sheet stacking device (15) according to claim 1, wherein the processing device (80) is to detect a size of the sheet (P) stacked in the sheet stacker (104) as the information of the sheet (P), based on the image data of the image captured by the image capturing device (110, 120).

3. The sheet stacking device (15) according to claim 2, wherein the processing device (80) is to:

cause the image capturing device (101) to capture an image of the sheet (P) stacked in the sheet stacker (104) together with a detection mark (106) formed on the sheet stacking device (15) to detect a position of the sheet (P) in a vertical direction; and
detect a sheet stacking amount of the sheet (P) stacked in the sheet stacker (104) based on image data of the image of the detection mark (106) and the sheet (P) stacked in the sheet stacker (104) simultaneously captured together by the image capturing device (110, 120).

4. The sheet stacking device (15) according to claim 2, wherein the processing device (80) is to detect whether the sheet (P) stacked in the sheet stacker (104) is a last sheet based on the image data of the image captured by the image capturing device (110, 120).

5. The sheet stacking device (15) according to claim 2, wherein the processing device (80) is to detect whether an image is formed on an image forming face of the sheet (P) based on the image data of the image captured by the image capturing device (110, 120).

6. The sheet stacking device (15) according to claim 2, further comprising a restraint (102) to restrict a position of the sheet (P) stacked in the sheet stacker (104),
wherein the processing device (80) is to:

cause the image capturing device (110) to simultaneously capture an image of the restraint (102) and the sheet (P) stacked in the sheet stacker (104); and
detect a distance between the sheet (P) stacked in the sheet stacker (104) and the restraint (106) based on image data of the image of the restraint (106) and the sheet (P) stacked in the sheet stacker (104) simultaneously captured by the image capturing device (110, 120).

7. The sheet stacking device (15) according to claim 2, wherein a component (101, 102, 103, 104) of the sheet stacking device (15) has an optical difference from the sheet (P) in the image data of the image captured by the image capturing device (110, 120).

8. An image forming apparatus (100) comprising:

the sheet stacking device (15) according to claim 2; and
an image forming device (10M, 10C, 10Y, 10K) to form an image on the sheet (P) fed from the sheet stacking device (15).

9. The image forming apparatus (100) according to claim 8, further comprising a notification device (70) to notify a user of the information detected based on the image data of the image captured by the image capturing device (110, 120).

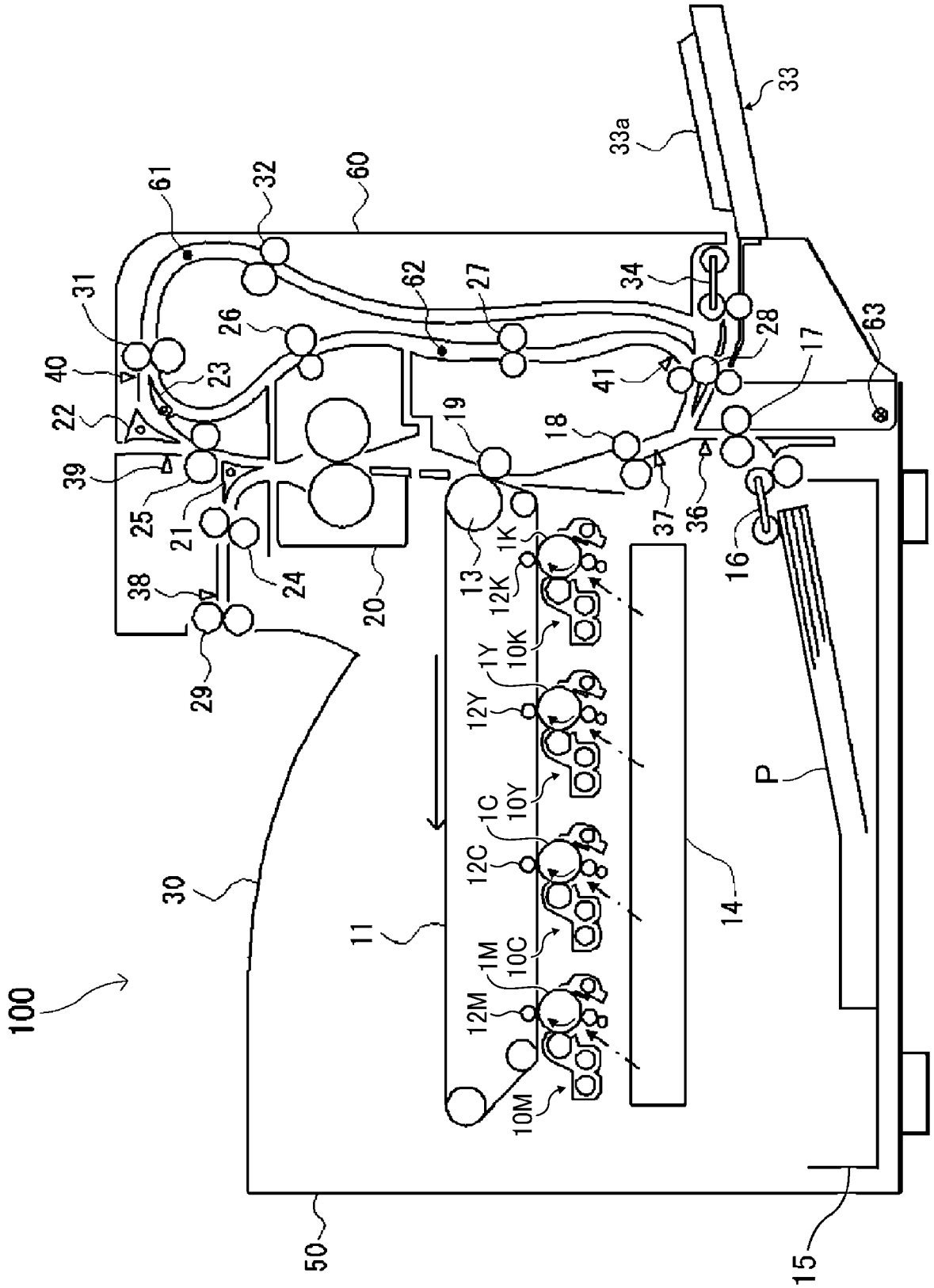
10. The sheet stacking device (15) according to claim 1, wherein the processing device (80) is to detect whether the sheet (P) stacked in the sheet stacker (104) is a last sheet as the information of the sheet (P), based on the image data of the image captured by the image capturing device (110, 120).

11. An image forming apparatus (100) comprising:

the sheet stacking device (15) according to claim 10; and
an image forming device (10M, 10C, 10Y, 10K) to form an image on a sheet (P) fed from the sheet stacking device (15).

12. The image forming apparatus (100) according to claim 11, further comprising a notification device (70) to notify a user of the information detected based on the image data of the image captured by the image capturing device (110, 120).

FIG. 1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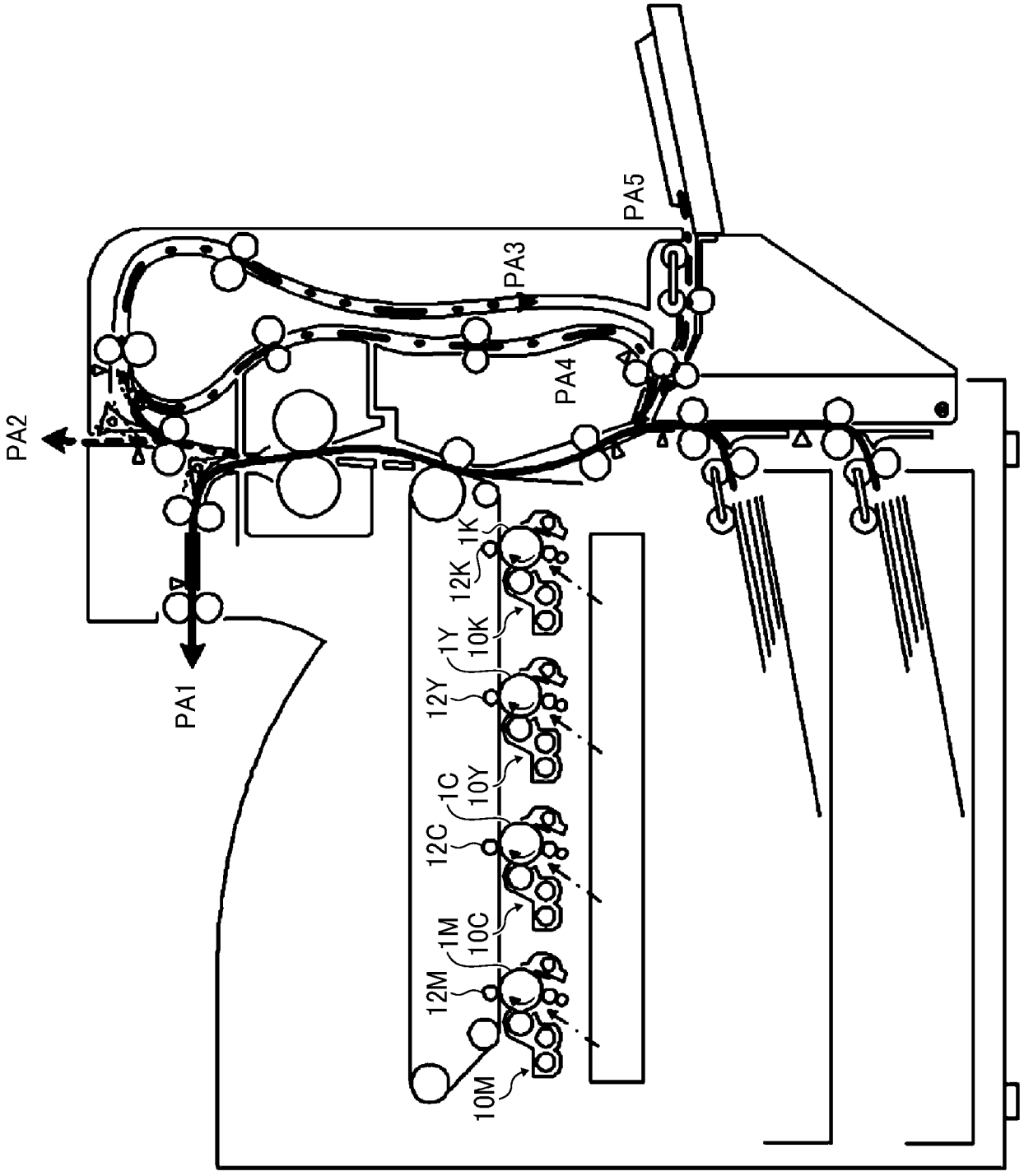


FIG. 2

FIG. 3

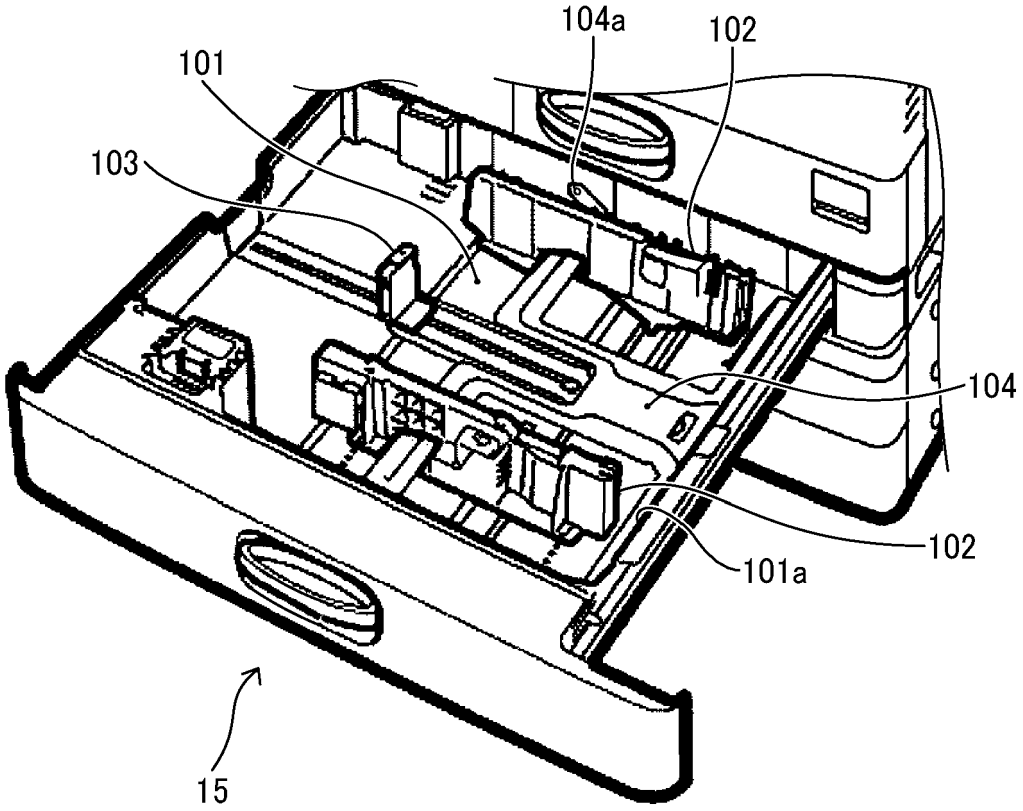
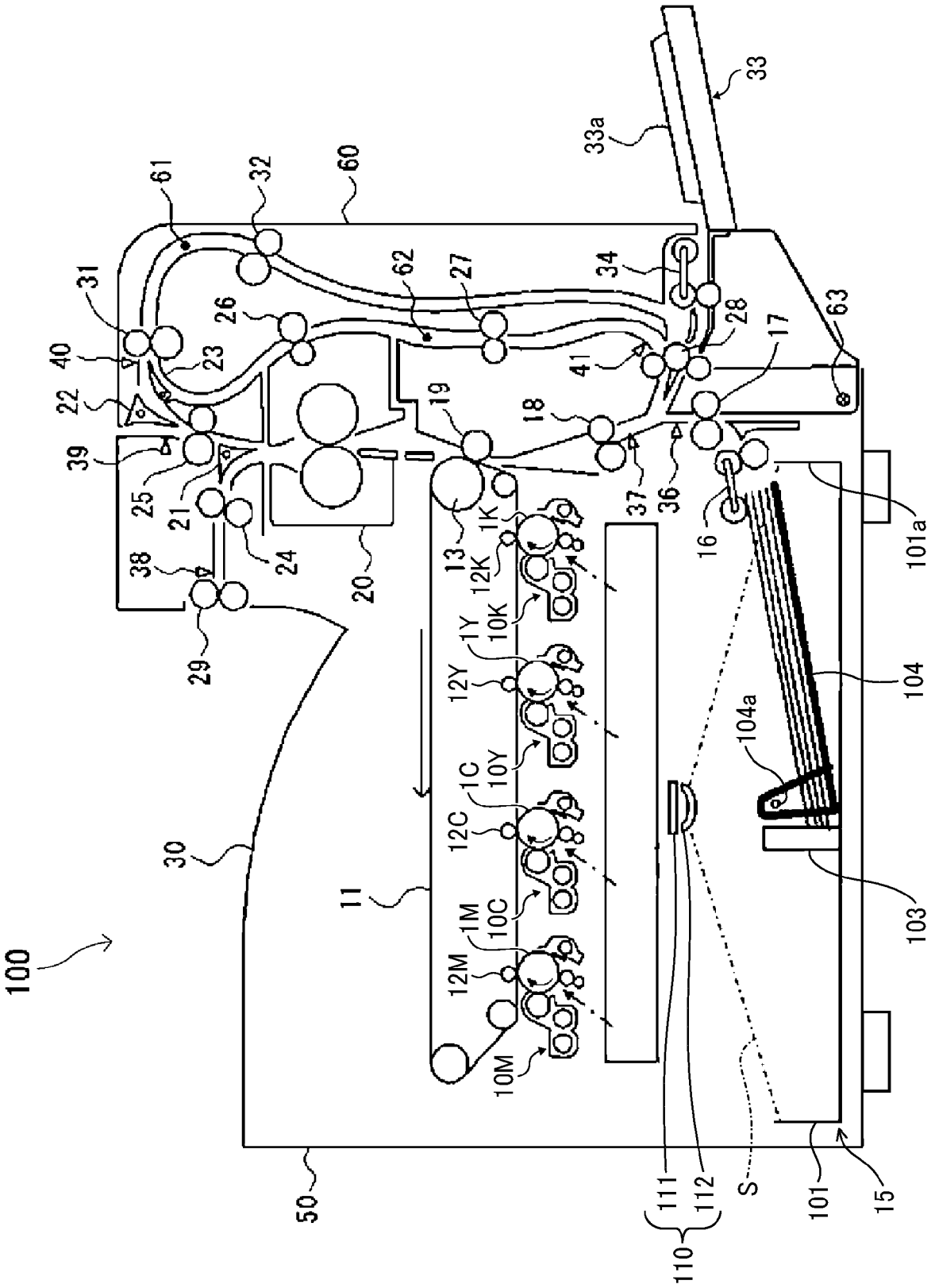


FIG. 4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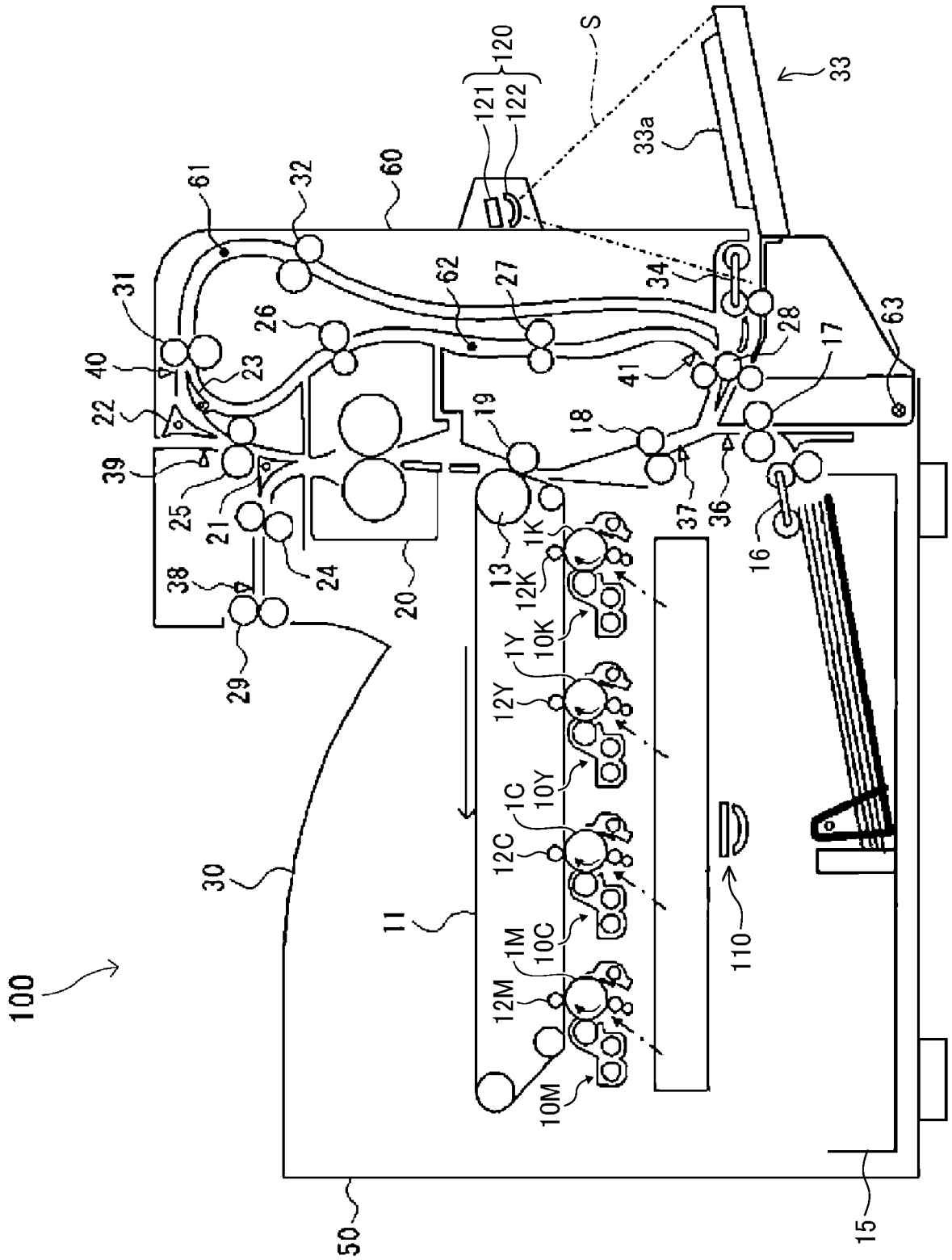
12M
12Y

FIG. 5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121
122
S
1K
1Y
1C
1M
10K
10Y
10C
10M
12K
12Y
12C
12M

FIG. 6

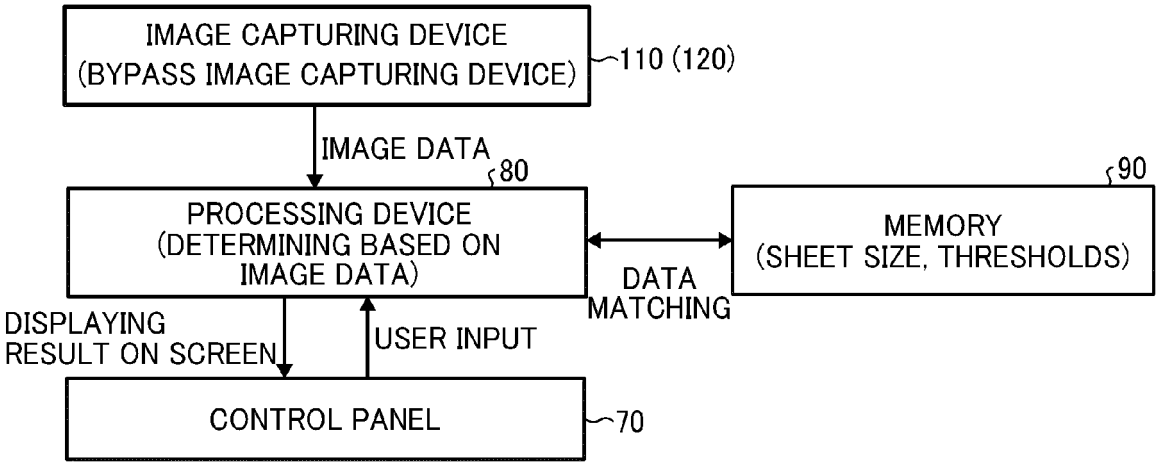


IMAGE CAPTURING DEVICE
(BYPASS IMAGE CAPTURING DEVICE)
110 (120)
IMAGE DATA
80
PROCESSING DEVICE
(DETERMINING BASED ON
IMAGE DATA)
90
MEMORY
(SHEET SIZE, THRESHOLDS)
DATA
MATCHING
DISPLAYING
RESULT ON SCREEN
USER INPUT
CONTROL PANEL
70

FIG. 7

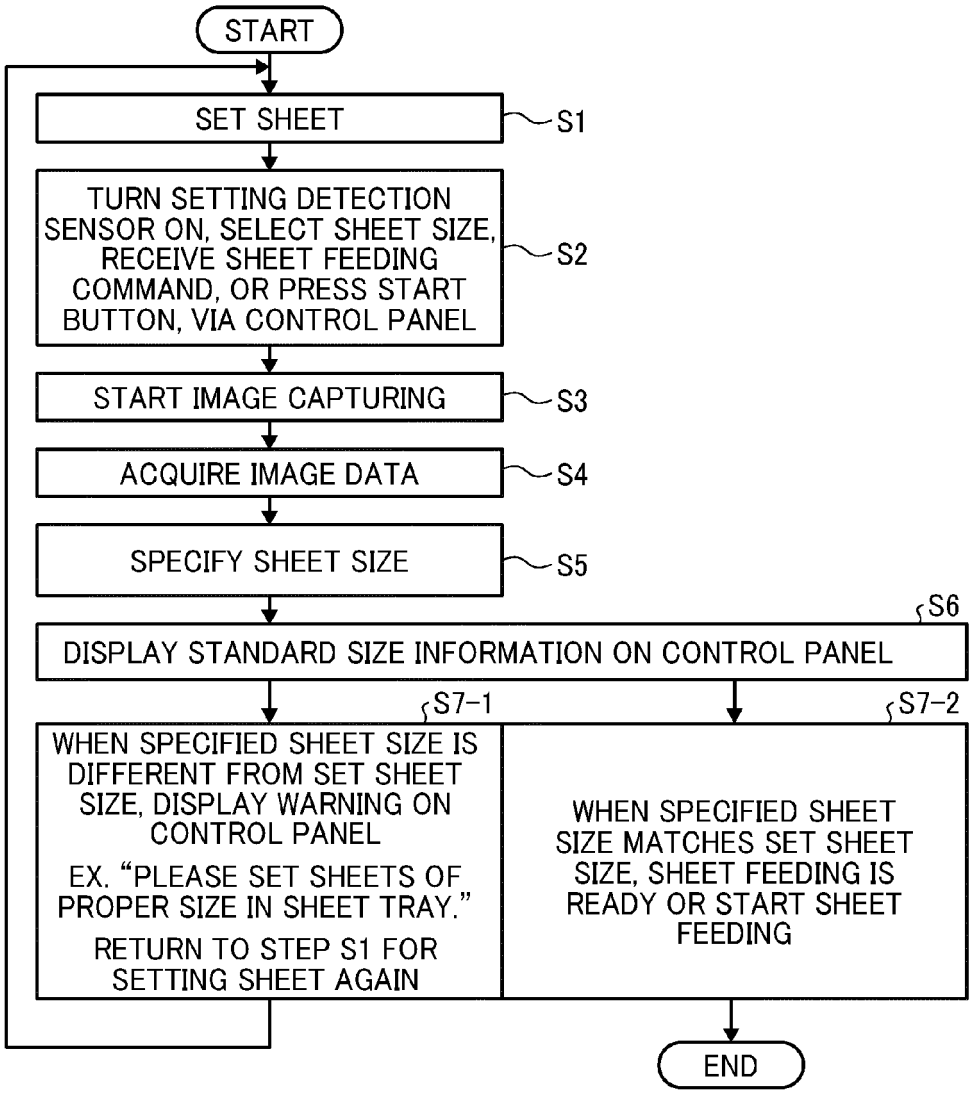

START
SET SHEET
S1
TURN SETTING DETECTION SENSOR ON, SELECT SHEET SIZE, RECEIVE SHEET FEEDING COMMAND, OR PRESS START BUTTON, VIA CONTROL PANEL
S2
START IMAGE CAPTURING
S3
ACQUIRE IMAGE DATA
S4
SPECIFY SHEET SIZE
S5
S6
DISPLAY STANDARD SIZE INFORMATION ON CONTROL PANEL
S7-1
WHEN SPECIFIED SHEET SIZE IS DIFFERENT FROM SET SHEET SIZE, DISPLAY WARNING ON CONTROL PANEL
EX. "PLEASE SET SHEETS OF PROPER SIZE IN SHEET TRAY."
RETURN TO STEP S1 FOR SETTING SHEET AGAIN
S7-2
WHEN SPECIFIED SHEET SIZE MATCHES SET SHEET SIZE, SHEET FEEDING IS READY OR START SHEET FEEDING
END

FIG. 8

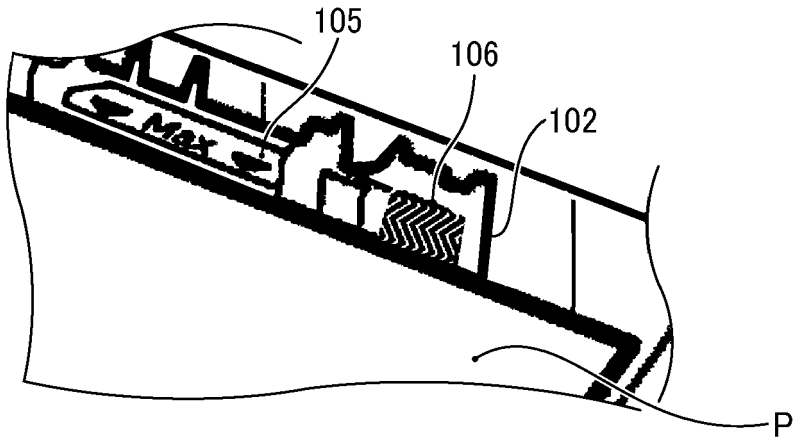


FIG. 9

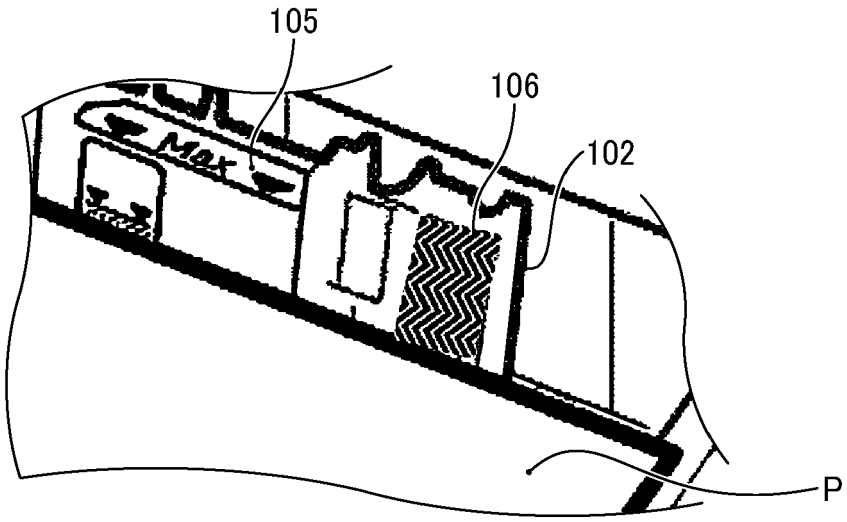


FIG. 10

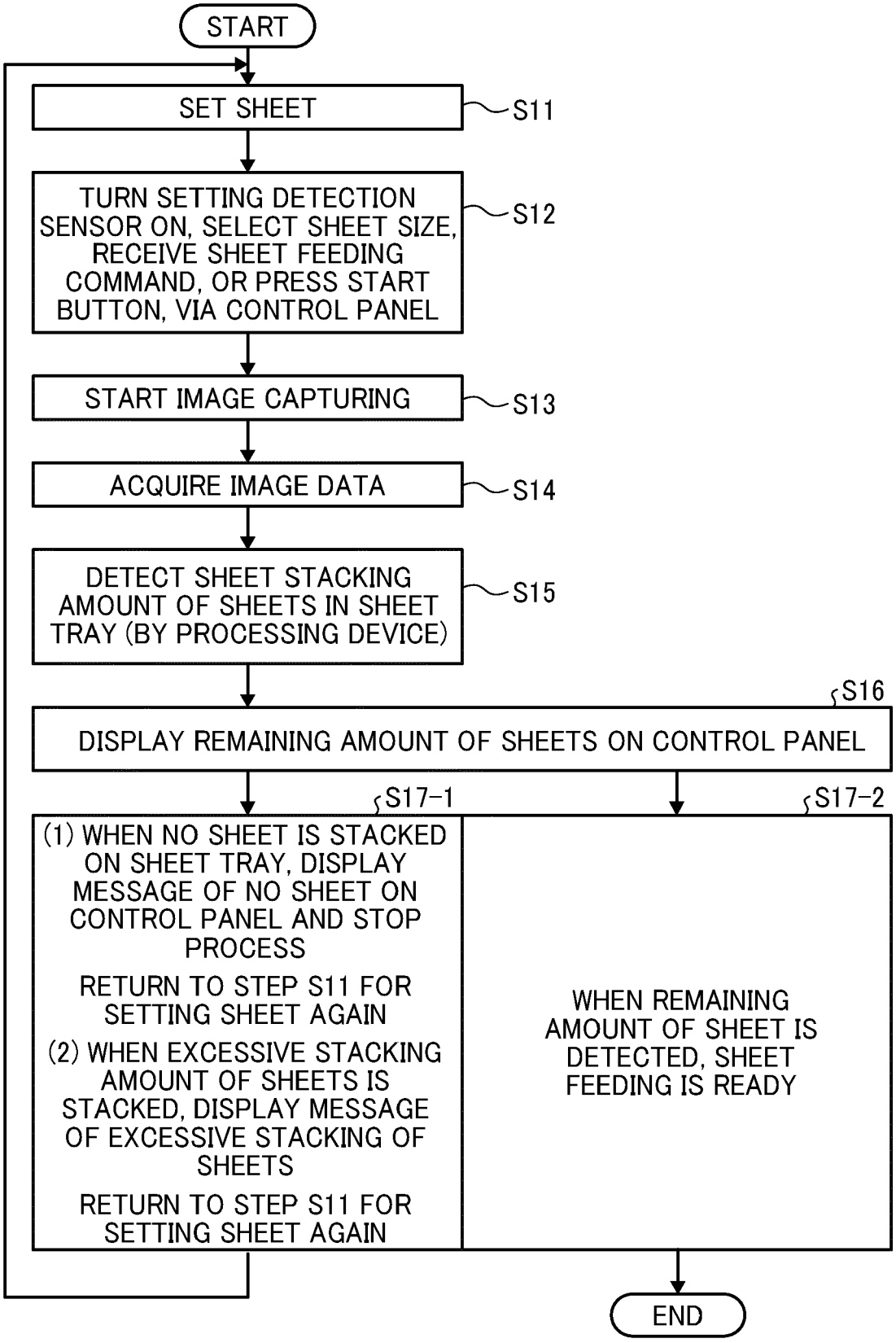

START
SET SHEET
S11
TURN SETTING DETECTION SENSOR ON, SELECT SHEET SIZE, RECEIVE SHEET FEEDING COMMAND, OR PRESS START BUTTON, VIA CONTROL PANEL
S12
START IMAGE CAPTURING
S13
ACQUIRE IMAGE DATA
S14
DETECT SHEET STACKING AMOUNT OF SHEETS IN SHEET TRAY (BY PROCESSING DEVICE)
S15
S16
DISPLAY REMAINING AMOUNT OF SHEETS ON CONTROL PANEL
S17-1
(1) WHEN NO SHEET IS STACKED ON SHEET TRAY, DISPLAY MESSAGE OF NO SHEET ON CONTROL PANEL AND STOP PROCESS
RETURN TO STEP S11 FOR SETTING SHEET AGAIN
(2) WHEN EXCESSIVE STACKING AMOUNT OF SHEETS IS STACKED, DISPLAY MESSAGE OF EXCESSIVE STACKING OF SHEETS
RETURN TO STEP S11 FOR SETTING SHEET AGAIN
S17-2
WHEN REMAINING AMOUNT OF SHEET IS DETECTED, SHEET FEEDING IS READY
END

FIG. 11

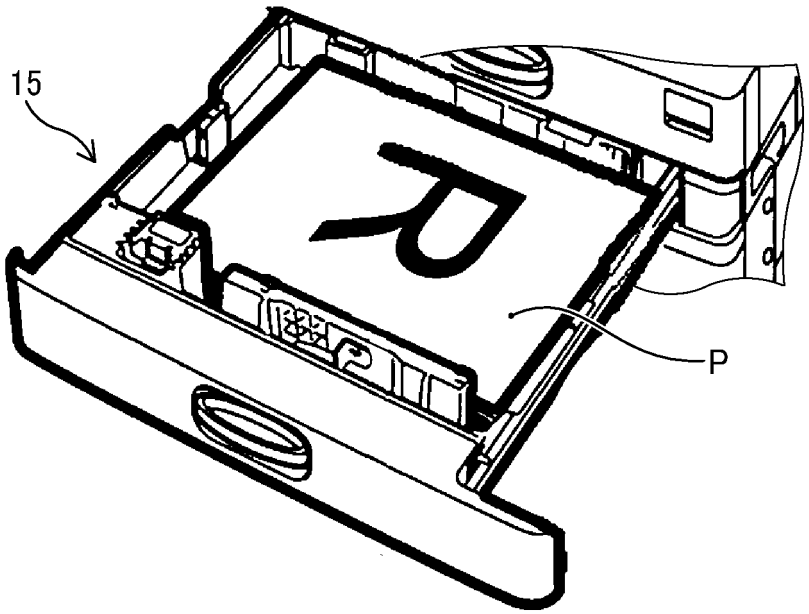


FIG. 12

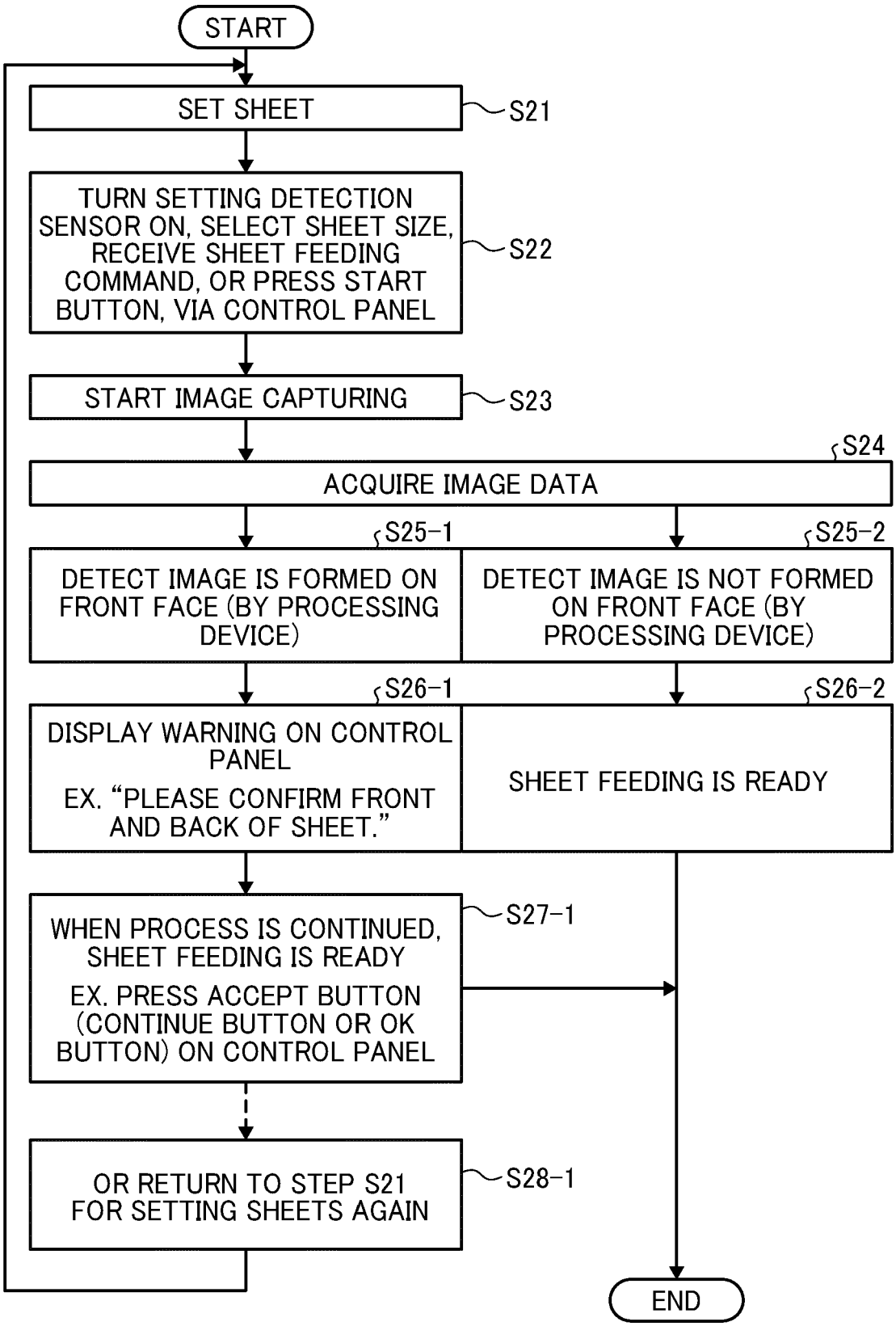

START
SET SHEET
S21
TURN SETTING DETECTION SENSOR ON, SELECT SHEET SIZE, RECEIVE SHEET FEEDING COMMAND, OR PRESS START BUTTON, VIA CONTROL PANEL
S22
START IMAGE CAPTURING
S23
S24
ACQUIRE IMAGE DATA
S25-1
S25-2
DETECT IMAGE IS FORMED ON FRONT FACE (BY PROCESSING DEVICE)
DETECT IMAGE IS NOT FORMED ON FRONT FACE (BY PROCESSING DEVICE)
S26-1
S26-2
DISPLAY WARNING ON CONTROL PANEL
EX. "PLEASE CONFIRM FRONT AND BACK OF SHEET."
SHEET FEEDING IS READY
WHEN PROCESS IS CONTINUED, SHEET FEEDING IS READY
EX. PRESS ACCEPT BUTTON (CONTINUE BUTTON OR OK BUTTON) ON CONTROL PANEL
S27-1
OR RETURN TO STEP S21 FOR SETTING SHEETS AGAIN
S28-1
END

FIG. 13

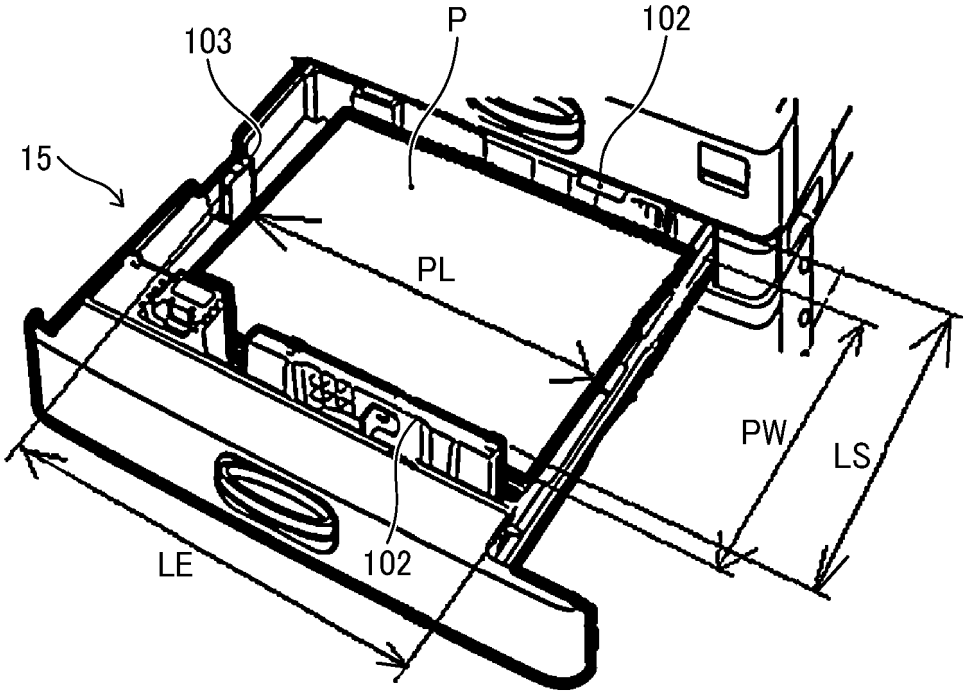


FIG. 14

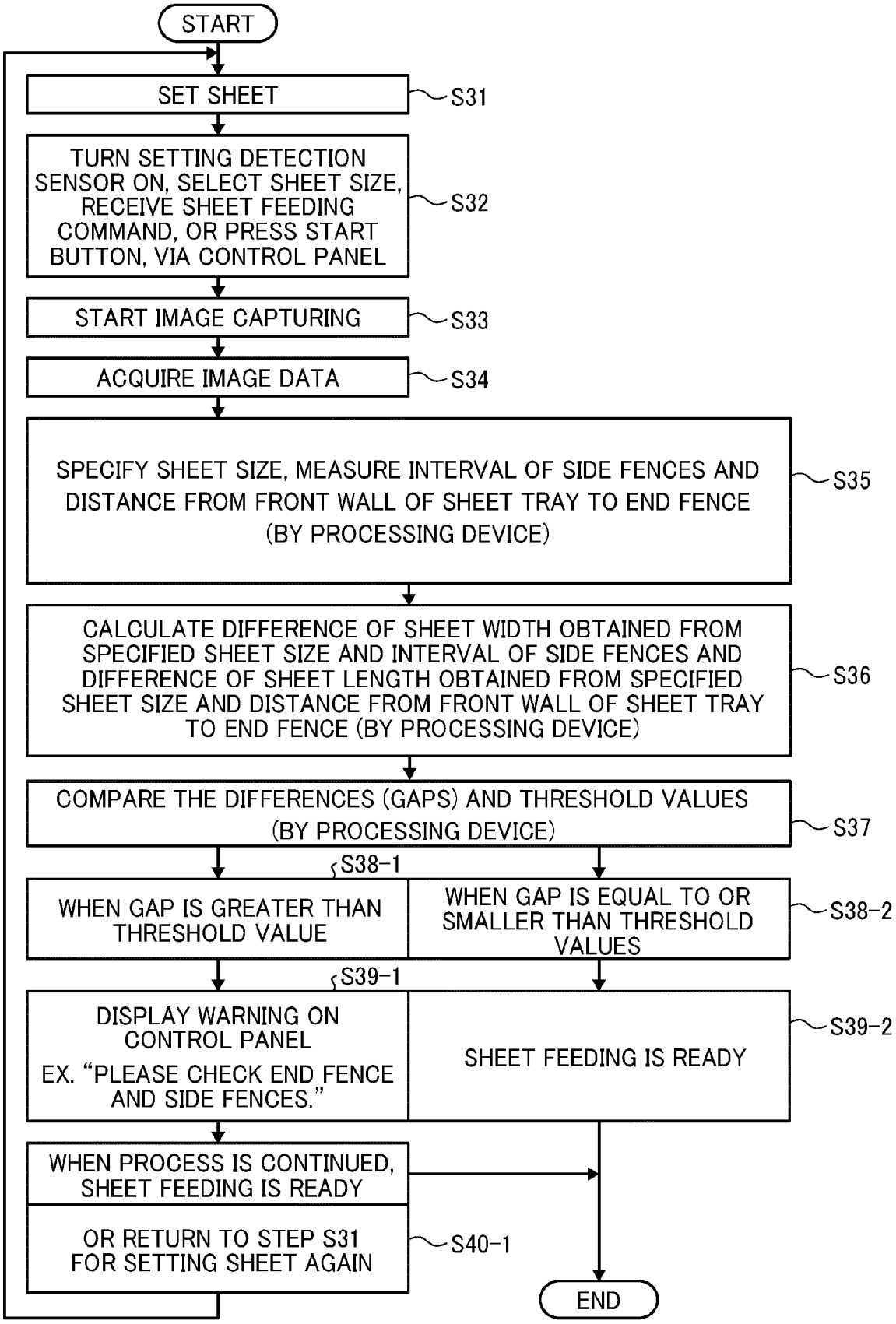

START
SET SHEET
S31
TURN SETTING DETECTION SENSOR ON, SELECT SHEET SIZE, RECEIVE SHEET FEEDING COMMAND, OR PRESS START BUTTON, VIA CONTROL PANEL
S32
START IMAGE CAPTURING
S33
ACQUIRE IMAGE DATA
S34
SPECIFY SHEET SIZE, MEASURE INTERVAL OF SIDE FENCES AND DISTANCE FROM FRONT WALL OF SHEET TRAY TO END FENCE (BY PROCESSING DEVICE)
S35
CALCULATE DIFFERENCE OF SHEET WIDTH OBTAINED FROM SPECIFIED SHEET SIZE AND INTERVAL OF SIDE FENCES AND DIFFERENCE OF SHEET LENGTH OBTAINED FROM SPECIFIED SHEET SIZE AND DISTANCE FROM FRONT WALL OF SHEET TRAY TO END FENCE (BY PROCESSING DEVICE)
S36
COMPARE THE DIFFERENCES (GAPS) AND THRESHOLD VALUES (BY PROCESSING DEVICE)
S37
S38-1
WHEN GAP IS GREATER THAN THRESHOLD VALUE
WHEN GAP IS EQUAL TO OR SMALLER THAN THRESHOLD VALUES
S38-2
S39-1
DISPLAY WARNING ON CONTROL PANEL
EX. "PLEASE CHECK END FENCE AND SIDE FENCES."
SHEET FEEDING IS READY
S39-2
WHEN PROCESS IS CONTINUED, SHEET FEEDING IS READY
OR RETURN TO STEP S31 FOR SETTING SHEET AGAIN
S40-1
END

FIG. 15

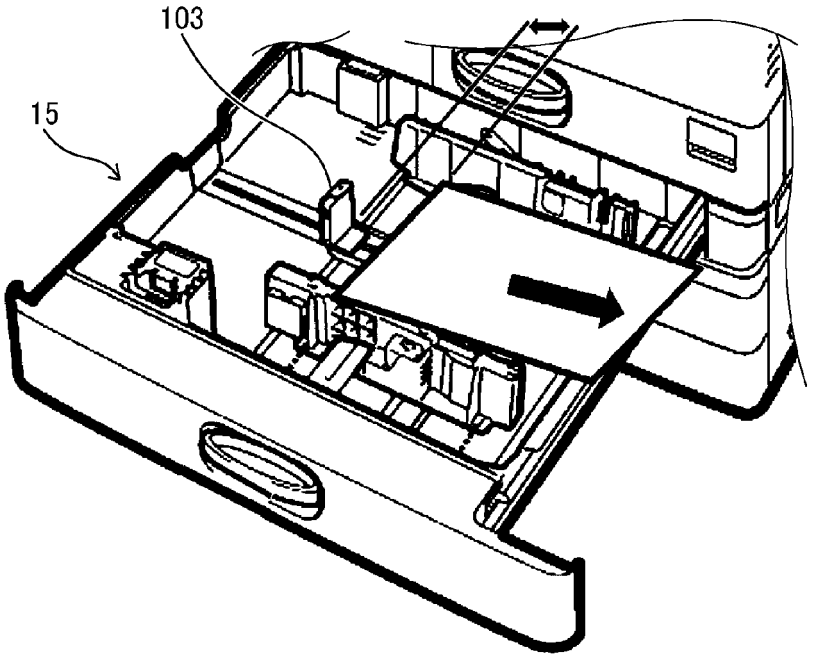
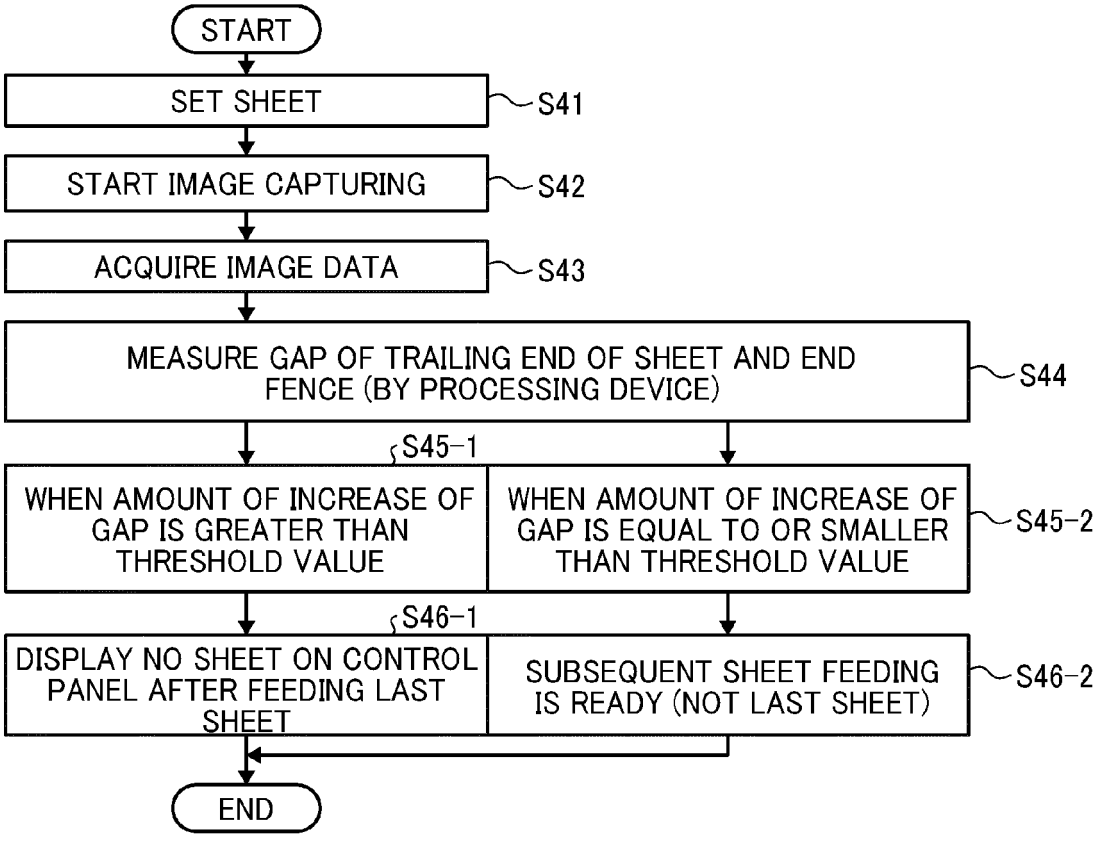

MOVEMENT RANGE AND DIRECTION
OF TRAILING END OF SHEET
103
15

FIG. 16


START
SET SHEET
S41
START IMAGE CAPTURING
S42
ACQUIRE IMAGE DATA
S43
MEASURE GAP OF TRAILING END OF SHEET AND END FENCE (BY PROCESSING DEVICE)
S44
S45-1
WHEN AMOUNT OF INCREASE OF GAP IS GREATER THAN THRESHOLD VALUE
WHEN AMOUNT OF INCREASE OF GAP IS EQUAL TO OR SMALLER THAN THRESHOLD VALUE
S45-2
S46-1
DISPLAY NO SHEET ON CONTROL PANEL AFTER FEEDING LAST SHEET
SUBSEQUENT SHEET FEEDING IS READY (NOT LAST SHEET)
S46-2
END

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EUROPEAN SEARCH REPORT

Application Number
EP 22 18 0975

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2005 041678 A (FUJI XEROX CO LTD) 17 February 2005 (2005-02-17) * the whole document *	1-12	INV. B65H1/04 B65H1/26 B65H7/02 B65H7/14 B65H7/04
X	JP 2020 083499 A (RICOH CO LTD) 4 June 2020 (2020-06-04) * the whole document *	1,2,6-9	
A	US 9 944 481 B2 (KIMBERLY CLARK CO [US]) 17 April 2018 (2018-04-17) * the whole document *	1	

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B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 November 2022	Athanasiadis, A

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16-11-2022

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- JP 2006188357 A **[0003]**
- JP 4324562 B **[0003]**