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IMAGE READING APPARATUS AND IMAGE FORMING SYSTEM

Abstract

Disclosed is an image reading apparatus including a reference member, a reader configured to read one of an original or the reference member, a mover configured to move the reader to a first region in which the original is read and a second region in which the reference member is read in a conveying direction of the original, and at least one processor configured to perform shading correction, wherein the at least one processor is configured to control the reader to move from outside of the second region to inside of the second region in the conveying direction to perform a first reading operation of reading the reference member within the second region.

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Background/Summary

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present disclosure relates to an image reading apparatus for reading an image from an original.

Description of the Related Art

[0002] An image reading apparatus can read an original by “fixed reading” in which an original placed on a platen is read or “flow reading” in which an original conveyed by an automatic document feeder (hereinafter abbreviated as “ADF”) is read. In the flow reading, a plurality of originals can be read successively. The image reading apparatus includes a reading unit in order to read the original. In the fixed reading, while the reading unit is moved in one direction below the platen, the reading unit reads the original one line by one line, assuming a direction orthogonal to the moving direction as one line. In the flow reading, the position of the reading unit is fixed, and the reading unit reads the original conveyed by the ADF to pass through a reading position one line by one line, assuming a direction orthogonal to the conveying direction of the original as one line. The direction of the one line is a main scanning direction, and the direction in which the reading unit moves or the conveying direction of the original is a sub-scanning direction.

[0003] The image reading apparatus is connected to an image forming apparatus to form a copying machine. There is a demand for the copying machine to reduce a first copy output time which is a time required from reading start of one original to output of a copied product.

[0004] The image reading apparatus performs shading processing as advance preparation before reading the original. The shading processing is processing of generating shading correction data for matching a reading result (reading data) of a white reference member with reference data. The shading correction data is a correction value for reading pixels in the main scanning direction of the original at a uniform density regardless of sensitivity unevenness of a reading sensor or light amount unevenness of a light source. With the shading correction being performed through use of the shading correction data, an image can be accurately read. The shading correction is performed by, for example, adjusting a light emitting amount of the light source or sensitivity of a light receiving element of the reading unit or correcting the read image.

[0005] In the shading processing, in a case where a foreign matter such as dust adheres to the white reference member, accurate shading correction data cannot be obtained. For example, in a case where a foreign matter adheres to the white reference member, reading data that is supposed to be a constant value after the shading correction becomes an abnormal value at the position of the foreign matter. The shading correction data generated based on such reading data has an abnormal value only at the position of the foreign matter. In a case where the shading correction is performed through use of such shading correction data, a reading image of the original may have, for example, a white streak caused at the position of the foreign matter. In order to address this issue, in U.S. Pat. No. 6,801,670, the position of the foreign matter is identified based on results of reading the white reference member a plurality of times at different positions in the sub-scanning direction, and the data of the position of the foreign matter in the shading correction data is corrected. The shading correction can be performed in accordance with the results acquired in one movement of the reading unit, however, there is further room for improvement in the acquisition of the results for shading correction.

SUMMARY OF THE INVENTION

[0006] An image reading apparatus according to one embodiment of the present disclosure includes a reference member, a reader configured to read one of an original or the reference member, a mover configured to move the reader to a first region in which the original is read and a second

region in which the reference member is read in a conveying direction of the original, and at least one processor configured to perform shading correction, wherein the at least one processor is configured to control the reader to move from outside of the second region to inside of the second region in the conveying direction to perform a first reading operation of reading the reference member within the second region, control the reader to move, after the first reading operation is performed, from the outside of the second region to the inside of the second region again and cause the reader to perform a second reading operation of reading the reference member within the second region, and perform the shading correction using a first reading result read in the first reading operation and a second reading result read in the second reading operation.
[0007] An image forming system according to another embodiment of the present disclosure includes an image reading apparatus, and an image forming apparatus configured to form an image onto a sheet based on image data generated by performing shading correction of a reading result of the original by the image reading apparatus, wherein the image reading apparatus includes a reference member, a reader configured to read one of an original or the reference member, a mover configured to move the reader to a first region in which the original is read and a second region in which the reference member is read in a conveying direction of the original, and at least one processor configured to perform the shading correction, and wherein the at least one processor is configured to control the reader to move from outside of the second region to inside of the second region in the conveying direction to perform a first reading operation of reading the reference member within the second region, control the reader to move, after the first reading operation is performed, from the outside of the second region to the inside of the second region again and cause the reader to perform a second reading operation of reading the reference member within the second region, and perform the shading correction using a first reading result read in the first reading operation and a second reading result read in the second reading operation.
[0008] Further features of the present invention will become apparent from the following description of exemplary embodiments (with reference to the attached drawings).

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0009] FIG. **1** is an external appearance perspective view of an automatic original reading apparatus.
[0010] FIG. **2** is an explanatory view of an operation unit.
[0011] FIG. **3** is an internal configuration view of the automatic original reading apparatus.
[0012] FIG. **4** is a configuration diagram of a control system.
[0013] FIG. **5**A, FIG. **5**B, FIG. **5**C, FIG. **5**D, and FIG. **5**E are explanatory views of shading processing.
[0014] FIG. **6**A and FIG. **6**B are explanatory graphs of the shading processing.
[0015] FIG. **7**A, FIG. **7**B, and FIG. **7**C are explanatory diagrams of an influence caused in a case where a foreign matter adheres to a white reference member.
[0016] FIG. **8** is a flow chart for illustrating abnormal pixel detection processing.
[0017] FIG. **9**A, FIG. **9**B, and FIG. **9**C are explanatory views of abnormal pixel detection.
[0018] FIG. **10** is a flow chart for illustrating processing of correcting an abnormal pixel.
[0019] FIG. **11** is an explanatory view of a result of abnormal pixel correction.
[0020] FIG. **12** is a flow chart for illustrating processing of reading the original.
[0021] FIG. **13** is a flow chart for illustrating abnormal pixel detection processing.
[0022] FIG. **14** is an explanatory view of abnormal pixel detection.
[0023] FIG. **15** is a flow chart for illustrating abnormal pixel correction processing.
[0024] FIG. **16** is a flow chart for illustrating processing of reading the original.

[0025] FIG. **17** is an explanatory view of sensors provided below a platen.
[0026] FIG. **18** is a flow chart for illustrating processing of reading the original.
[0027] FIG. **19** is a flow chart for illustrating processing of reading the original.
[0028] FIG. **20** is a flow chart for illustrating processing of reading the original.
[0029] FIG. **21** is a configuration view of an image forming system.

DESCRIPTION OF THE EMBODIMENTS

[0030] Now, preferred embodiments of the present disclosure are described with reference to the attached drawings.

First Embodiment

[0031] FIG. **1** is an external appearance perspective view of an automatic original reading apparatus including an image reading apparatus of a first embodiment of the present disclosure. An automatic original reading apparatus **10** includes an image reading apparatus (hereinafter referred to as “reader **40**”) for reading an original, and an ADF **20** for automatically conveying the original to a reading position at which the original is read by the reader **40**. The ADF **20** functions as a sheet conveying device for conveying a sheet-shaped original to the reader **40**.

[0032] The automatic original reading apparatus **10** includes an operation unit. FIG. **2** is an explanatory view of the operation unit. An operation unit **90** is a user interface including an input interface and an output interface. The input interface is an operation key group **92** including a start key **93** in FIG. **2**. The input interface may include, for example, a touch panel in addition thereto. The output interface is a display unit **91** in FIG. **2**. The output interface may include, for example, a speaker in addition thereto.

[0033] FIG. **3** is an internal configuration view of the automatic original reading apparatus **10**. The reader **40** includes a platen **101** between the reader **40** and the ADF **20**. The ADF **20** is turnably supported to the reader **40** by a hinge (not shown) so that the ADF **20** is openable and closable with respect to the platen **101**. The reader **40** and the ADF **20** each include a reading unit for reading an original. The reader **40** includes a front surface reading unit **104** for reading a first surface (the first surface is hereinafter also referred to as “front surface”) of the original. The ADF **20** includes a back surface reading unit **212** for reading a second surface (the second surface is hereinafter also referred to as “back surface”) which is different from the first surface of the original. The original may be white paper, or the original may have an image formed on one surface or both surfaces thereof.

[0034] The ADF **20** includes an original tray **121** on which originals are to be stacked, and a discharge tray **122** to which the original subjected to reading is to be discharged. The original tray **121** forms a sheet stacking unit **120** together with a conveyance lower guide **123** of the ADF **20**. The original tray **121** includes, on an original stacking surface, width restricting plates **125** which are movable in a width direction orthogonal to a conveying direction of the original. The width restricting plates **125** restrict the position in the width direction of the original placed on the original tray **121**. Two width restricting plates **125** are provided in the width direction, and the two width restricting plates **125** sandwich the original placed on the original tray **121**.

[0035] The two width restricting plates **125** use an interlocking mechanism (not shown), for example, a rack-and-pinion mechanism arranged in the original tray **121** so that movement of one of the two width restricting plates **125** causes the other of the two width restricting plates **125** to move in association therewith. In the first embodiment, a conveyance center of the original is at a middle in the width direction, and the two width restricting plates **125** are configured to come close to or separate from the middle in the width direction. In this manner, the conveyance center of the original is always at the same position regardless of the size of the original. Further, through measurement of an interval between the two width restricting plates **125**, a size in the width direction of the original placed on the original tray **121** can be detected.

[0036] The ADF **20** includes, in order to feed the original from the original tray **121**, a pick-up roller **111** serving as a conveyance rotary member, and a separation drive roller **112** and a retard roller **113** forming a separation roller pair. The ADF **20** includes, in order to convey the fed original, a registration roller pair **114***a* and **114***b*, a read roller pair **115***a* and **115***b*, a conveyance roller pair **117***a* and **117***b*, and a discharge roller pair **119***a* and **119***b*.

[0037] A first original presence/absence detection sensor **204** and a second original presence/absence detection sensor **205** are provided between the pick-up roller **111** and the separation roller pair. A post-separation sensor **207** is provided in a conveyance path between the separation roller pair and the registration roller pair **114***a* and **114***b*. A read sensor **210** is provided in a conveyance path between the registration roller pair **114***a* and **114***b* and the read roller pair **115***a* and **115***b*. The back surface reading unit **212** is provided in a conveyance path between the read roller pair **115***a* and **115***b* and the conveyance roller pair **117***a* and **117***b*.

[0038] The reader **40** includes a front surface reading glass **102** on the same surface as the platen **101**, and includes the front surface reading unit **104** inside of the reader **40**. The front surface reading glass **102** is provided with a front-surface white reference member **103** directed inward of the reader **40**, and is also provided with a back-surface white reference member **110** directed outward of the reader **40**. The front-surface white reference member **103** and the back-surface white reference member **110** are used for shading processing. At least the front-surface white reference member **103** uses an inexpensive product employing a sheet having unevenness on its surface.

[0039] Although details are described later, shading correction is performed based on a reading result of the front-surface white reference member **103** obtained by the front surface reading unit **104**. However, the front-surface white reference member **103** has unevenness on its surface, and hence there is a possibility that accurate shading correction data cannot be acquired. Variations in shading correction data due to unevenness cause variations in luminance of a reading image in a case where the original is read. Variations in luminance due to unevenness of a sheet surface are smaller than variations in luminance due to a foreign matter. Accordingly, it is difficult to detect and correct the unevenness of the sheet surface as in the case of the foreign matter.

[0040] Shading correction data that is suppressed in influence of a foreign matter or unevenness can be acquired based on a plurality of pieces of reading data obtained by reading the front-surface white reference member **103** a plurality of times. However, the variations in luminance due to the foreign matter are large, and hence, in order to suppress the influence of the foreign matter, it is required to take a large reading region (shading region) of the front-surface white reference member **103**.

[0041] The front surface reading unit **104** is arranged on a guide **109**, and is movable along the guide **109**. The front surface reading unit **104** is positioned right below the front surface reading glass **102** in a case where the front surface reading unit **104** reads the original conveyed by the ADF **20**, and moves along the guide **109** in a case where the front surface reading unit **104** reads the original placed on the platen **101**.

[0042] In the first embodiment, an operation mode of reading the original conveyed by the ADF **20** is referred to as “flow reading mode,” and an operation mode of reading the original placed on the platen **101** is referred to as “fixed reading mode.” The flow reading mode is set in a case where the first original presence/absence detection sensor **204** detects an original stacked on the original tray **121** or in a case where a user gives an explicit instruction through the operation unit **90** or the like. The fixed reading mode is set in a case where the original placed on the platen **101** is detected or in a case where the user gives an explicit instruction through the operation unit **90**.

[0043] An operation of conveying the original by the ADF **20** is described. The pick-up roller **111** is provided so as to be rockable by an arm **111***a*. The arm **111***a* is driven to be raised and lowered so that the pick-up roller **111** is brought into abutment against or separated from the uppermost original of a bundle of originals stacked on the original tray **121**. The arm **111***a* is provided in conjunction with a locking mechanism for locking a restriction plate **130** to be brought into abutment against an edge portion of the original. This locking mechanism locks the restriction plate

130 at a position for restricting a leading edge position of the original, under a state in which the pick-up roller **111** is raised. Further, the locking mechanism cancels the locking of the restriction plate **130** under a state in which the pick-up roller **111** is lowered so that passage of the original is allowed.

[0044] On the upstream side with respect to the restriction plate **130** in the conveying direction of the original, a detection member **160** of the first original presence/absence detection sensor **204** and a detection member **150** of the second original presence/absence detection sensor **205** are arranged side by side in the width direction. The detection member **160** and the detection member **150** are arranged on the downstream side in the conveying direction of the original with respect to the pick-up roller **111**, specifically, on the downstream side in the conveying direction with respect to the position at which the pick-up roller **111** is lowered to abut against the original. The first original presence/absence detection sensor **204** outputs an on-signal in a case where the detection member **160** is pressed downward and turned by the original. The second original presence/absence detection sensor **205** outputs an on-signal in a case where the detection member **150** is pressed upward and turned by the original. The presence or absence of the original on the original tray **121** is determined based on the signals output from the first original presence/absence detection sensor **204** and the second original presence/absence detection sensor **205**.

[0045] The original fed by the pick-up roller **111** is separated one by one and conveyed by the separation drive roller **112** and the retard roller **113**. A torque limiter is arranged in a rotation support structure of the retard roller **113**. The retard roller **113** follows the separation drive roller **112** in a case where the number of fed originals is one, but does not rotate in a case where the number of fed originals is two or more. In this manner, the originals are separated one by one. The retard roller **113** may be driven in a direction opposite to the conveying direction. At the time of the fixed reading mode, simultaneously with the lowering of the pick-up roller **111**, the front surface reading unit **104** moves to a position right below a conveyance guide plate **211** in order to read the conveyed original.

[0046] A leading edge and a trailing edge of the original that has passed through the separation roller pair are detected by the post-separation sensor **207**. Detection results obtained by the post-separation sensor **207** become references of a raising or lowering timing and drive start and drive stop timings of the pick-up roller **111**. The pick-up roller **111** and the separation drive roller **112** are driven by the same drive source.

[0047] The registration roller pair **114***a* and **114***b* corrects skew feeding of the original. The original subjected to skew feeding correction by the registration roller pair **114***a* and **114***b* is conveyed by the read roller pair **115***a* and **115***b* toward the front surface reading glass **102**. The drive timings of the registration roller pair **114***a* and **114***b* and the read roller pair **115***a* and **115***b* are controlled based on the detection results obtained by the post-separation sensor **207**. The conveyance guide plate **211** is arranged so as to be opposed to the front surface reading glass **102**. The conveyance guide plate **211** guides the original so as to prevent the original passing between the conveyance guide plate **211** and the front surface reading glass **102** from coming off from the front surface reading glass **102**. The position of the conveyance guide plate **211** becomes a reading position of reading the original by the front surface reading unit **104**. The registration roller pair **114***a* and **114***b* and the read roller pair **115***a* and **115***b* are driven by the same drive source.

[0048] In a case where one surface of the original is to be read, an image on the front surface of the original is read by the front surface reading unit **104** through the front surface reading glass **102**. The front surface reading unit **104** includes a light emitting diode (LED) **105** serving as a light source, a lens array **107**, and a reading sensor **108** which is a line sensor.

[0049] In the front surface reading unit **104**, the LED **105** irradiates the front surface (reading surface) of the original with light. The reflected light from the front surface of the original passes through the lens array **107** so as to be received by the reading sensor **108**. The reading sensor **108** includes a plurality of light receiving elements arrayed on a straight line, and each light receiving element receives the reflected light. Each light receiving element photoelectrically converts the reflected light so as to generate and output image data as a reading result of the original. The plurality of light receiving elements are arrayed in a direction orthogonal to the conveying direction of the original, and perform photoelectrical conversion for each line. The LED **105** linearly applies light in an array direction of the light receiving elements. Because of this configuration, the direction orthogonal to the conveying direction of the original is the main scanning direction, and the conveying direction of the original is the sub-scanning direction.

[0050] The original whose front surface has been read by the front surface reading unit **104** is discharged to the discharge tray **122** by the conveyance roller pair **117***a* and **117***b* and the discharge roller pair **119***a* and **119***b*. The conveyance roller pair **117***a* and **117***b* and the discharge roller pair **119***a* and **119***b* are driven by the same drive source.

[0051] In a case where both surfaces of the original are to be read, the image on the front surface of the original is read by the front surface reading unit **104**, and the image on the back surface of the original is read by the back surface reading unit **212**. The back surface reading unit **212** has a configuration similar to that of the front surface reading unit **104**, and includes an LED **214** serving as a light source, a lens array **215**, and a reading sensor **216** which is a line sensor. The back surface reading unit **212** reads the back surface of the original whose front surface has been read by the front surface reading unit **104**. The reading operation of the original performed by the back surface reading unit **212** is similar to that performed by the front surface reading unit **104**. Further, the main scanning direction and the sub-scanning direction are also the same.

[0052] In the fixed reading mode, which does not use the ADF **20**, the original is placed on the platen **101** with its reading surface being directed toward the reader **40** side. In this case, the original on the platen **101** does not move, and the front surface reading unit **104** reads the original while moving right below the platen **101** along the guide **109**. The reading operation performed by the front surface reading unit **104** itself is similar to that at the time of the flow reading mode. In the fixed reading mode, the moving direction of the front surface reading unit **104** is the sub-scanning direction, and a direction orthogonal to the moving direction is the main scanning direction.

[0053] FIG. **4** is a configuration diagram of a control system for controlling the operation of the automatic original reading apparatus **10**. The control system includes a controller **310** and a configuration provided in a section shown as the reader **40**. The controller **310** may be provided in the automatic original reading apparatus **10**, but, in a case where the automatic original reading apparatus **10** is connected to an external apparatus, for example, an image forming apparatus, the controller **310** may be provided on the image forming apparatus side. Through connection to the automatic original reading apparatus **10**, such an image forming apparatus forms, for example, a copying machine, a facsimile apparatus, a multifunction machine, or a multifunction peripheral (MFP).

[0054] The configuration provided in the section of the reader **40** is an information processing device including a central processing unit (CPU) **301**, a read only memory (ROM) **302**, and a random access memory (RAM) **303**. In the section of the reader **40**, an image memory **305**, an image processor **306**, a shading memory **307**, and an image transfer unit **304** are also provided as the control system. The image transfer unit **304** is connected to the controller **310** via an image transfer line **402** so that communication is allowed therebetween. Further, the reader **40** includes an optical system HP sensor **226** and an optical system motor **225** in addition to the configuration described with reference to FIG. **3**. The ADF **20** includes a feeding clutch **223** and a conveyance motor **224** in addition to the configuration described with reference to FIG. **3**.

[0055] The CPU **301** executes a computer program stored in the ROM **302** to control the operations of the reader **40** and the ADF **20**. The RAM **303** provides a work area used in a case where the CPU **301** executes processing. The CPU **301** is connected to each component of the reader **40** and the ADF **20** via a bus so that communication is allowed therebetween. The CPU **301** is connected to the controller **310** via a communication line **401** so that communication is allowed therebetween.

[0056] The CPU **301** drives and controls the conveyance motor **224** for driving each of the above-mentioned rollers for conveying the original, in order to implement an original conveyance function by the ADF **20**. The conveyance motor **224** is connected to the pick-up roller **111** and the separation drive roller **112** via the feeding clutch **223**. In a case where the feeding clutch **223** is disconnected, the conveyance of the original can be stopped at a position P (see FIG. **3**) right before arrival to the registration roller pair **114***a* and **114***b*. Further, the conveyance motor **224** is connected to the registration roller pair **114***a* and **114***b*, the read roller pair **115***a* and **115***b*, the conveyance roller pair **117***a* and **117***b*, and the discharge roller pair **119***a* and **119***b* so as to drive those roller pairs.

[0057] The conveyance motor **224** is a pulse motor. The CPU **301** controls the number of drive pulses to drive and control the conveyance motor **224**. The number of drive pulses has a correlation with a conveying distance of the original during conveyance. Accordingly, the CPU **301** controls each load based on the conveying distance derived from the number of drive pulses to perform conveyance of the original.

[0058] The CPU **301** detects the presence or absence of the original on the original tray **121** based on detection results of the first original presence/absence detection sensor **204** and the second original presence/absence detection sensor **205**. The CPU **301** detects the position of the original conveyed through the conveyance path based on the detection results of the post-separation sensor **207** and the read sensor **210**.

[0059] The optical system motor **225** is a drive source for moving the front surface reading unit **104** in the sub-scanning direction along the guide **109**. The optical system motor **225** is driven and controlled by the CPU **301**. The optical system HP sensor **226** is a sensor for detecting that the front surface reading unit **104** is positioned at a home position (HP).

[0060] The front surface reading unit **104** includes the LED **105** and the reading sensor **108** as described above. In the front surface reading unit **104**, the reading sensor **108** receives the reflected light of the light applied from the LED **105** to the conveyed original so that image data which is a reading result is generated. The back surface reading unit **212** includes the LED **214** and the reading sensor **216** as described above. In the back surface reading unit **212**, the reading sensor **216** receives the reflected light of the light applied from the LED **214** to the conveyed original so that image data which is a reading result is generated. The image data output from each of the front surface reading unit **104** and the back surface reading unit **212** is temporarily stored in the image memory **305**. The image data represents a reading image.

[0061] The processing of reading the original by the front surface reading unit **104** and the back surface reading unit **212** is controlled by the CPU **301**. The CPU **301** causes the front surface reading unit **104** and the back surface reading unit **212** to perform the processing of reading the original in response to detection of the original by the read sensor **210**.

[0062] The image processor **306** corrects reading data (reading image) stored in the image memory **305** by predetermined image processing on the reading data. The shading memory **307** is connected to the image processor **306**, and holds shading correction data to be described later. The CPU **301** can read out data held in the shading memory **307** and write data via the image processor **306**. The image transfer unit **304** transfers the image data subjected to image processing by the image processor **306** to the controller **310** via the image transfer line **402**.

[0063] The controller **310** controls the entire operation of an image reading system including the reader **40** and the ADF **20**. The controller **310** includes a CPU **311**, a ROM **312**, a RAM **313**, an image transfer unit **314**, and an image memory **315**. Those components are connected to each other via a bus so that communication is allowed therebetween. The operation unit **90** is also connected to this bus.

[0064] The CPU **311** executes a computer program stored in the ROM **312** to control the operation of the controller **310**. The CPU **311** receives an instruction or the like input through the operation

unit **90**. The CPU **311** displays a message, a read image, or the like on the display unit **91** of the operation unit **90**. The RAM **313** provides a work area used in a case where the CPU **311** executes processing. The image transfer unit **314** acquires the image data from the image transfer unit **304** of the reader **40** via the image transfer line **402** and stores the image data into the image memory **315**.
[0065] The CPU **311** performs image reading control for the automatic original reading apparatus **10** in cooperation with the CPU **301**. Accordingly, the CPU **311** performs transmission and reception of control data such as an instruction relating to the image reading control via the communication line **401** between the CPU **311** and the CPU **301**.
[0066] For example, the CPU **311** acquires an instruction to start an image reading job from the operation unit **90**, and transmits a reading start instruction to the CPU **301**. The instruction to start the image reading job includes information such as an instruction of black and white reading or color reading, a reading resolution, a reading original size, and an image reading job start instruction. The reading start instruction includes control information such as an original feeding start instruction and an original reading instruction. The original feeding start instruction includes information on the reading resolution, and the original reading instruction includes information on the reading original size. Further, the CPU **311** acquires information indicating the state of the automatic original reading apparatus **10** from the CPU **301**, and causes the operation unit **90** to display a message to a user corresponding to the state of the apparatus.
Shading Correction
[0067] The front-surface white reference member **103** and the back-surface white reference member **110** are white reference plates for use in creating correction data for correcting the white level by shading. The front-surface white reference member **103** is used for generation of the shading correction data for the front surface reading unit **104**. The back-surface white reference member **110** is used for generation of the shading correction data for the back surface reading unit **212**. Through image processing on the reading result (reading data) of the front-surface white reference member **103** obtained by the front surface reading unit **104**, the shading correction data for the front surface reading unit **104** is generated. Through image processing on the reading result (reading data) of the back-surface white reference member **110** obtained by the back surface reading unit **212**, the shading correction data for the back surface reading unit **212** is generated. The shading correction data is generated before the original is read.
[0068] FIG. **5**A to FIG. **5**E and FIG. **6**A and FIG. **6**B are explanatory diagrams of the shading processing of the front surface reading unit **104**. FIG. **5**A shows a state in which the front surface reading unit **104** starts moving from a position P**1** which is the home position. That is, the front surface reading unit **104** moves from outside of a region for reading the front-surface white reference member **103** to inside of the region. FIG. **5**B shows a state in which the front surface reading unit **104** has moved from the position P**1** via a position P**2** to a position P**3**. FIG. **5**C shows a state in which the front surface reading unit **104** has moved from the position P**3** via the position P**2** to the position P**1**. FIG. **5**D shows a state in which the front surface reading unit **104** has moved from the position P**1** via the position P**2** to the position P**3**. FIG. **5**E shows a state in which the front surface reading unit **104** has moved to a reading start position Ps. In a case where the flow reading is performed in the flow reading mode, the front surface reading unit **104** reads the original at the reading start position Ps. In a case where the fixed reading is performed in the fixed reading mode, the front surface reading unit **104** reads the original while moving from the reading start position Ps in the sub-scanning direction. That is, the front surface reading unit **104** moves from outside of a region for reading the original to inside of the region.
[0069] In the shading processing of the front surface reading unit **104**, the front surface reading unit **104** reads the front-surface white reference member **103** while moving from the position P**1** to the position P**3** right below the front-surface white reference member **103**. FIG. **6**A is an exemplary graph of a reading result of one line. FIG. **6**A shows a reading level (for example, a luminance value) of each position (each pixel) in the main scanning direction. In the shading processing, a

correction coefficient of each pixel is derived so that the reading level of each pixel as in FIG. **6**A is corrected to a predetermined white level Tgtw as shown in FIG. **6**B. This correction coefficient is the front-surface shading correction data, and is stored in the shading memory **307**.

[0070] The back surface reading unit **212** is fixed to the ADF **20**, and reads the back-surface white reference member **110** without moving unlike the front surface reading unit **104** at the time of the shading processing. The correction coefficient of each pixel is derived based on the reading result (reading level) of the back-surface white reference member **110** obtained by the back surface reading unit **212**, similarly to the front surface. This correction coefficient is the back-surface shading correction data, and is stored in the shading memory **307**.

[0071] The shading correction data is formed of pieces of data (correction values) corresponding to the number of pixels in the main scanning direction for each of the three primary colors (red, green, and blue) of the light source. In a case where the original is read, the image processor **306** generates image data by correcting the reading image (reading data) of one line through use of the shading correction data stored in the shading memory **307**, for example, every time the original is read by one line. The image processor **306** stores the image data generated through correction into the image memory **305**.

Abnormal Pixel Detection

[0072] In a case where a foreign matter such as dust adheres to the front-surface white reference member **103** or the back-surface white reference member **110**, an abnormal value is included in the reading level of the reading result, and thus accurate shading correction data cannot be obtained. FIG. **7**A to FIG. **7**C are explanatory views of the influence caused in a case where a foreign matter adheres to the white reference member.

[0073] FIG. **7**A shows the reading level of each position (each pixel) in the main scanning direction which is the reading result of the white reference member having a foreign matter (dust) adhering thereto. There is a pixel having an abnormally lower reading level as compared to other pixels due to the influence of the dust. FIG. **7**B shows a reading level in a case in which the reading result of the white reference member without adhesion of dust is corrected by the shading correction data obtained from the reading result of FIG. **7**A. The reading level of the pixel at the position of adhesion of dust is abnormally higher than the reading levels of other pixels. FIG. **7**C shows a copied image obtained after shading correction is performed through use of such shading correction data at the time of copying the original. A white streak image is generated at the position of the dust.

[0074] A position (pixel) in the main scanning direction that has an abnormal reading result in a case where a foreign matter adheres to the white reference member as described above is referred to as “abnormal pixel.” Description is given of abnormal pixel detection performed in a case where a foreign matter adheres to the front-surface white reference member **103**. In the first embodiment, the abnormal pixel detection for the front-surface white reference member **103** is performed by detecting a pixel having an abnormal value from the shading correction data (shading correction coefficient). The shading correction data of the detected abnormal pixel is corrected by being interpolated through use of shading correction data of a pixel adjacent to the abnormal pixel.

[0075] FIG. **8** is a flow chart for illustrating abnormal pixel detection processing. FIG. **9**A to FIG. **9**C are explanatory views of the abnormal pixel detection. Description is given of a case in which, as illustrated in FIG. **9**A, foreign matters (dust) adhere to positions of a pixel A and a pixel B in the main scanning direction of the front-surface white reference member **103**. The pixel A has a position in the sub-scanning direction of the position P**1**. The pixel B has a position in the sub-scanning direction between the position P**2** and the position P**3**.

[0076] The CPU **301** of the reader **40** moves the front surface reading unit **104** to the position P**1** (home position) of FIG. **5**A (Step S**110**). The position P**1** is hereinafter also referred to as “HP position.” In a case where the front surface reading unit **104** is already at the HP position, the processing step of Step S**110** is omitted. Whether or not the front surface reading unit **104** is at the

HP position is determined by the detection result obtained by the optical system HP sensor **226**.

[0077] The CPU **301** causes the front surface reading unit **104** to read the front-surface white reference member **103** at the HP position under a state in which the LED **105** is turned off, to thereby perform black level adjustment (Step S**111**). In the black level adjustment, luminance unevenness correction in the main scanning direction is performed under an LED off state (dark time), and the output variations at the dark time of the front surface reading unit **104** are mainly corrected. Through correction of the output variations at the dark time, the luminance unevenness in the main scanning direction at the time of black original reading is corrected, and the input dynamic range can be ensured at the same time.

[0078] The CPU **301** causes the front surface reading unit **104** to read the front-surface white reference member **103** under a reading setting set so that the maximum value of the reading result (luminance value) becomes darker than that at the time of normal image reading. Accordingly, the CPU **301** turns on the LED **105** at the HP position (Step S**112**), and causes the front surface reading unit **104** to read the front-surface white reference member **103** (Step S**113**). The CPU **301** acquires reference shading correction data for abnormal pixel detection based on the reading result (reading data). The reference shading correction data is obtained from an addition average result of values of pieces of reading data of the respective pixels in the main scanning direction. FIG. **9**B is an exemplary graph of the reference shading correction data. At the position of the pixel A, the value of the reading data becomes darker (lower) than those of the surrounding pixels due to the influence of the dust, and hence the correction coefficient for correcting the pixel so that the pixel becomes white is a value higher than the values of the surroundings.

[0079] The CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** from the HP position to the position P**3** (Step S**114**). In this manner, the front surface reading unit **104** is moved from the state of FIG. **5**A to the state of FIG. **5**B. The CPU **301** reads the front-surface white reference member **103** while moving the front surface reading unit **104** based on the reference shading correction data (Step S**115**). In this case, the front surface reading unit **104** reads the front-surface white reference member **103** in a region from the position P**2** to the position P**3** a plurality of times while moving from the position P**1** to the position P**3** of FIG. **5**B.

[0080] The CPU **301** stands by until the front surface reading unit **104** is moved to the position P**3** and the reading of the front-surface white reference member **103** is ended (Step S**116**: N). After the reading of the front-surface white reference member **103** is ended (Step S**116**: Y), the CPU **301** performs abnormal pixel detection for the front-surface white reference member **103** (Step S**117**). The CPU **301** detects the abnormal pixel from an addition average result of values of pieces of reading data of the respective pixels in the main scanning direction.

[0081] FIG. **9**C shows an addition average result of the reading results (pieces of reading data) obtained by the processing step of Step S**115**. In this case, a luminance value is obtained as the reading result. With the shading correction using the reference shading correction data, the pixels in the main scanning direction entirely have a uniform luminance. However, at the position of the pixel A, the front-surface white reference member **103** is read under a state in which the shading correction coefficient is high due to the influence of dust, and hence the luminance value is high. At the position of the pixel B, the luminance value is low because the dust is read.

[0082] The CPU **301** compares the reading data and a predetermined dust detection threshold value so as to detect a pixel having reading data equal to or lower than the dust detection threshold value as the abnormal pixel. The dust detection threshold value for determining the abnormal pixel is set based on the average luminance value (average value of pieces of reading data) of the pixels of one line in the main scanning direction. The reading is performed a plurality of times, and hence a value obtained by averaging average luminance values of the respective lines for a plurality of lines may be set as the dust detection threshold value. The CPU **301** stores the position of the detected abnormal pixel into a memory such as the RAM **303** (Step S**118**). In this manner, only a pixel at which dust is present in a region from the position P**2** to the position P**3** can be detected. The CPU

301 reversely rotates the optical system motor **225** to move the front surface reading unit **104** from the position P**3** to the HP position (P**1**) as illustrated in FIG. **5**C, and ends the abnormal pixel detection (Step S**119**).

Abnormal Pixel Correction

[0083] FIG. **10** is a flow chart for illustrating processing of correcting the detected abnormal pixel. The front surface reading unit **104** that has performed detection of the abnormal pixel by the processing of FIG. **8** stands by at the HP position (P**1**) under a state in which the LED **105** is turned on.

[0084] The CPU **301** drives the optical system motor **225** to start movement of the front surface reading unit **104** from the HP position to the position P**3** as illustrated in FIG. **5**D (Step S**120**). The CPU **301** reads the front-surface white reference member **103** a plurality of times in the region from the position P**2** to the position P**3** while moving the front surface reading unit **104** under the setting at the time of the normal image reading (Step S**121**).

[0085] The CPU **301** stands by until the front surface reading unit **104** is moved to the position P**3** and the reading of the front-surface white reference member **103** is ended (Step S**122**: N). After the reading is ended (Step S**122**: Y), the CPU **301** performs abnormal pixel correction of the reading result (reading data) of the front-surface white reference member **103** (Step S**123**).

[0086] FIG. **11** is an explanatory view of a result of the abnormal pixel correction. The shading correction data obtained from the reading data includes an abnormal value caused by the foreign matter at the pixel B. In a case where the abnormal value of the abnormal pixel (pixel B) is to be corrected, linear interpolation is performed through use of shading correction data of a pixel (reference pixel) having a normal value adjacent to the abnormal pixel. In FIG. **11**, interpolation of the abnormal pixel B is performed through use of an interpolation pixel included in the reference pixel. In this manner, shading correction data suppressed in influence of the abnormal pixel is generated.

Reading of Original

[0087] FIG. **12** is a flow chart for illustrating processing of reading the original by the automatic original reading apparatus **10** having the configuration as described above. FIG. **12** shows processing of reading one surface (front surface) of the original in the flow reading mode using the ADF **20**.

[0088] The CPU **301** of the reader **40** stands by until a reading start instruction is acquired from the CPU **311** of the controller **310** (Step S**101**: N). As described above, the CPU **311** of the controller **310** acquires the instruction to start the image reading job from the operation unit **90** or an external apparatus such as a personal computer to transmit the reading start instruction to the CPU **301** of the reader **40**. In a case where the CPU **311** acquires the instruction to start the image reading job, the CPU **311** transmits the reading start instruction to the CPU **301** of the reader **40**. In a case where the CPU **301** acquires the reading start instruction from the CPU **311** (Step S**101**: Y), the CPU **301** performs abnormal pixel detection processing for the front-surface white reference member **103** illustrated in FIG. **8** (Step S**102**).

[0089] After the execution of the abnormal pixel detection processing, the CPU **301** performs the abnormal pixel correction processing for the front-surface white reference member **103** illustrated in FIG. **10** (Step S**103**). After the abnormal pixel correction processing is ended, the CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** to the reading start position Ps illustrated in FIG. **5**E, and starts the reading of the original (Step S**104**). After the movement of the front surface reading unit **104** to the reading start position Ps is finished, the CPU **301** causes the ADF **20** to convey the original to the reading position of the front surface reading unit **104**, and performs reading of the original. The front surface reading unit **104** repeatedly reads the conveyed original one line by one line.

[0090] The CPU **301** stands by until the reading of all originals is ended (Step S**105**: N). The CPU **301** determines that the reading of all originals is ended when, for example, based on the detection results of the first original presence/absence detection sensor **204** and the second original presence/absence detection sensor **205**, the absence of the original placed on the original tray **121** is detected. After the reading of all originals is ended (Step S**105**: Y), the CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** to the HP position (P**1**), and ends the processing (Step S**106**).

[0091] In the above-mentioned example, description is given of a case in which the flow reading is performed, but in a case where the fixed reading is performed, the original is placed on the platen **101**. After the processing steps of from Step S**101** to Step S**103** are ended, the CPU **301** moves the front surface reading unit **104** to the reading start position Ps. After that, the CPU **301** repeatedly reads the original placed on the platen **101** one line by one line while moving the front surface reading unit **104** in the sub-scanning direction.

[0092] As described above, at the time of detecting the abnormal pixel of the front-surface white reference member **103** and the time of correcting the abnormal pixel of the front-surface white reference member **103**, the automatic original reading apparatus **10** (reader **40**) of the first embodiment reads the front-surface white reference member **103** while moving the front surface reading unit **104**. In this manner, even when an inexpensive white reference member is used, the automatic original reading apparatus **10** (reader **40**) can detect the abnormal pixel of the white reference member without being affected by the unevenness of the surface of the white reference member. Thus, accurate shading correction can be performed.

Second Embodiment

[0093] A configuration of the automatic original reading apparatus **10** and a configuration of the control system in a second embodiment of the present disclosure are similar to those in the first embodiment, and hence description of the configuration of the automatic original reading apparatus **10** and the configuration of the control system is omitted. The second embodiment is similar to the first embodiment in processing other than the abnormal pixel detection for the front-surface white reference member **103**. Description of the similar processing is omitted.

[0094] The abnormal pixel detection for the front-surface white reference member **103** in the second embodiment is performed based on the reading result (reading data) of the front-surface white reference member **103** obtained by the front surface reading unit **104**. In this case, description is given of a case in which foreign matters (dust) adhere to positions (pixel A and pixel B) exemplified in FIG. **9**A. FIG. **13** is a flow chart for illustrating abnormal pixel detection processing. FIG. **14** is an explanatory view of abnormal pixel detection.

[0095] Similarly to the processing steps of Step S**110** and Step S**111** of the abnormal pixel detection processing in the first embodiment of FIG. **8**, the CPU **301** moves the front surface reading unit **104** to the HP position to perform black level adjustment (Step S**610** and Step S**611**). The CPU **301** turns on the LED **105** (Step S**612**), and drives the optical system motor **225** to start movement of the front surface reading unit **104** from the HP position to the position P**3** as illustrated in FIG. **5**B (Step S**613**).

[0096] The CPU **301** successively reads the front-surface white reference member **103** from the position P**2** to the position P**3** while moving the front surface reading unit **104** (Step S**614**). The CPU **301** stands by until the reading from the position P**2** to the position P**3** is ended (Step S**615**: N). After the reading is ended (Step S**615**: Y), the CPU **301** performs abnormal pixel detection for the front-surface white reference member **103** (Step S**616**).

[0097] The luminance values of the reading results (pieces of reading data) in the region from the position P**2** to the position P**3** of the front-surface white reference member **103** entirely have unevenness as exemplified in FIG. **14** due to the unevenness of the surface. At the pixel B, the luminance value becomes extremely lower than those of other pixels. The dust detection threshold value for determining the abnormal pixel is set based on an average luminance value (average value of pieces of reading data) for each predetermined width in the main scanning direction. In FIG. **14**, one line in the main scanning direction is divided into a plurality of sections of first to fifth dust detection sections, and the dust detection threshold value is set for each dust detection section.

[0098] The CPU **301** detects a position of a pixel (in this case, the pixel B) having a luminance value which is a reading result equal to or lower than the dust detection threshold value as the abnormal pixel, and stores the position of the detected abnormal pixel into a memory such as the RAM **303** (Step S**617**). In this manner, even when the reading result (reading data) has unevenness, the position of the abnormal pixel can be accurately detected. The CPU **301** reversely rotates the optical system motor **225** to move the front surface reading unit **104** from the position P**3** to the HP position (P**1**) as illustrated in FIG. **5**C, and ends the abnormal pixel detection (Step S**618**).

[0099] Also in the second embodiment, similarly to the first embodiment, even when an inexpensive white reference member is used, it is possible to detect the abnormal pixel of the white reference member without being affected by the unevenness of the surface of the white reference member. Thus, accurate shading correction can be performed. Further, even when the reading data has unevenness entirely in the main scanning direction, the threshold value for detecting the abnormal pixel is set for each section obtained by dividing the main scanning direction into a plurality of sections, and hence the abnormal pixel can be accurately detected.

Third Embodiment

[0100] A configuration of the automatic original reading apparatus **10** and a configuration of the control system in a third embodiment of the present disclosure are similar to those in the first embodiment, and hence description of the configuration of the automatic original reading apparatus **10** and the configuration of the control system is omitted. In the third embodiment, the abnormal pixel detection processing is similar to that in the first embodiment, and hence description thereof is omitted. Also in the third embodiment, the abnormal pixel detection processing in the second embodiment is effective. The third embodiment is different from the first embodiment and the second embodiment in the abnormal pixel correction processing and the original reading processing.

[0101] FIG. **15** is a flow chart for illustrating the abnormal pixel correction processing in the third embodiment.

[0102] The CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** to the HP position (Step S**250**). In a case where the front surface reading unit **104** is already at the HP position, the processing step of Step S**250** is omitted. The CPU **301** causes the front surface reading unit **104** to read the front-surface white reference member **103** at the HP position under a state in which the LED **105** is turned off, to thereby perform black level adjustment (Step S**251**). This processing step is similar to the processing step of Step S**111** of FIG. **8**. After that, the CPU **301** turns on the LED **105** (Step S**252**). The CPU **301** corrects the abnormal pixel through processing steps similar to the processing steps of Step S**120** to Step S**123** of FIG. **10** in the first embodiment (Step S**253** to Step S**256**).

[0103] The shading correction data generated based on the reading result (reading data) of the front-surface white reference member **103** obtained in the processing step of Step S**254** is similar to the shading correction data obtained in the processing step of Step S**121** of FIG. **10** in the first embodiment. In this case, the shading correction data is as illustrated in FIG. **11**. The abnormal pixel correction is performed by, similarly to the first embodiment, as illustrated in FIG. **11**, linear interpolation of the shading correction data of the abnormal pixel through use of the shading correction data of a normal pixel adjacent to the abnormal pixel. In this manner, the shading correction data suppressed in influence of the abnormal pixel can be obtained.

[0104] FIG. **16** is a flow chart for illustrating processing of reading the original in the third embodiment. FIG. **16** shows processing of reading one surface (front surface) of the original in the flow reading mode using the ADF **20**.

[0105] The CPU **301** stands by until the automatic original reading apparatus **10** is powered on (Step S**201**: N). In a case where the automatic original reading apparatus **10** is powered on (Step

S**201**: Y), the CPU **301** performs the abnormal pixel detection processing for the front-surface white reference member **103** described above, and stores the abnormal pixel position (Step S**202**). The CPU **301** turns off the LED **105** after the abnormal pixel detection processing (Step S**203**), and stands by until the reading start instruction described above is acquired (Step S**204**: N).

[0106] After the CPU **301** acquires the reading start instruction from the CPU **311** (Step S**204**: Y), the CPU **301** performs the abnormal pixel correction processing illustrated in FIG. **15** (Step S**205**). After the abnormal pixel correction processing is ended, the CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** to the reading start position Ps illustrated in FIG. **5**E, and performs reading of the original (Step S**206**). This processing step is similar to the processing step of Step S**104** of FIG. **12**.

[0107] Similarly to the processing step of Step S**105** of FIG. **12**, the CPU **301** stands by until the reading of all of the originals is ended (Step S**207**: N). After the reading of all of the originals is ended (Step S**207**: Y), the CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** to the HP position (P**1**) (Step S**208**). After the front surface reading unit **104** is moved to the HP position (P**1**), the CPU **301** repeatedly performs the processing steps of from Step S**204** to Step S**208** until the automatic original reading apparatus **10** is powered off (Step S**209**: N). In a case where the automatic original reading apparatus **10** is powered off (Step S**209**: Y), the CPU **301** ends the original reading processing.

[0108] In the above-mentioned example, description is given of a case in which the flow reading is performed, but in a case where the fixed reading is performed, the original is placed on the platen **101**. After the processing steps of from Step S**201** to Step S**205** are ended, the CPU **301** moves the front surface reading unit **104** to the reading start position Ps. After that, the CPU **301** repeatedly reads the original placed on the platen **101** one line by one line while moving the front surface reading unit **104** in the sub-scanning direction.

[0109] In the processing of FIG. **16**, it is determined in the processing step of Step S**201** and the processing step of Step S**209** whether or not the power of the automatic original reading apparatus **10** is operated, but this determination may be determination as to a power saving state (sleep state). That is, the CPU **301** waits for the recovery from the power saving state in the processing step of Step S**201**, and determines whether the state has shifted to the power saving state in the processing step of Step S**209**.

[0110] In the third embodiment described above, the front-surface white reference member **103** is read while the front surface reading unit **104** is moved at the time of abnormal pixel detection for the white reference member and the time of the abnormal pixel correction for the white reference member. Accordingly, even when an inexpensive white reference member is used, the abnormal pixel of the white reference member can be detected without being affected by the unevenness of the surface of the white reference member. Thus, accurate shading correction can be performed. Further, the abnormal pixel detection for the white reference member is performed in advance at the time of start-up of the automatic original reading apparatus **10** (at the time of power-on or at the time of recovery from the power saving state) so that a time period required from reading start to end can be shortened.

Fourth Embodiment

[0111] A configuration of the automatic original reading apparatus **10** and a configuration of the control system in a fourth embodiment of the present disclosure are similar to those in the first embodiment, and hence description of the configuration of the automatic original reading apparatus **10** and the configuration of the control system is omitted. In the fourth embodiment, the abnormal pixel detection processing is similar to that in the first embodiment or the second embodiment, and hence description thereof is omitted. In the fourth embodiment, the abnormal pixel correction processing is similar to that in the third embodiment, and hence description thereof is omitted.

[0112] In the fourth embodiment, placement of the original onto the original tray **121** of the ADF **20** or the platen **101** is detected. In a case where the first original presence/absence detection sensor

204 detects the original, it can be determined that the original has been placed onto the original tray **121** of the ADF **20**. In a case where the first original presence/absence detection sensor **204** detects no original, it can be determined that the original has been removed from the top of the original tray **121**.

[0113] The placement of the original onto the platen **101** can be detected by providing a sensor below the platen **101**. FIG. **17** is an explanatory view of sensors provided below the platen **101**. In FIG. **17**, a plurality of original detection sensors **180**, **181**, **182**, and **183** for detecting presence or absence of the original on the platen **101** are provided below the platen **101**. In a case where at least one of the original detection sensors **180**, **181**, **182**, and **183** detects the original, it can be determined that the original is placed on the platen **101**. In a case where none of the original detection sensors **180**, **181**, **182**, and **183** detects the original, it can be determined that the original has been removed from the top of the platen **101**. The original detection sensors **180**, **181**, **182**, and **183** are, for example, optical sensors, and can detect the presence or absence of the original based on whether or not light applied toward the platen **101** is reflected.

[0114] In a case where the original placement onto the original tray **121** of the ADF **20** and the original placement onto the platen **101** are both detected, it is determined that the original has been placed on the original tray **121**. Further, in a case where no original is detected on any of the original tray **121** of the ADF **20** and the platen **101**, it is determined that the original is placed on the platen **101**.

[0115] FIG. **18** is a flow chart for illustrating processing of reading the original in the fourth embodiment. FIG. **18** shows processing of reading one surface (front surface) of the original.

[0116] The CPU **301** determines whether or not the reading start instruction has been acquired similarly to Step S**101** of FIG. **12** (Step S**301**). In a case where no reading start instruction is acquired (Step S**301**: N), the CPU **301** determines whether the original placement onto the original tray **121** of the ADF **20** or the original placement onto the platen **101** has been performed (Step S**302**). In a case where no original is placed on any of the original tray **121** of the ADF **20** and the platen **101** (Step S**302**: N), the process returns to the processing step of S**301**, and the CPU **301** determines whether the reading start instruction has been acquired. In a case where it is determined that the original has been placed (Step S**302**: Y), the CPU **301** determines whether or not a predetermined time period has elapsed from the previous abnormal pixel detection processing (Step S**303**). Accordingly, the CPU **301** includes a built-in timer to count the elapsed time period from the previous abnormal pixel detection processing. In a case where the predetermined time period has elapsed (Step S**303**: Y), the CPU **301** performs the abnormal pixel detection processing described above (Step S**304**). The predetermined time period in Step S**303** is, for example, 6 hours, but may be 0 hours. In a case where the predetermined time period is 0 hours, the abnormal pixel detection processing is performed every time the original is placed.

[0117] In a case where the predetermined time period has not elapsed (Step S**303**: N), or after the abnormal pixel detection processing is performed, the CPU **301** turns off the LED **105** of the front surface reading unit **104** (Step S**305**). The CPU **301** sets a flag (abnormal pixel detection execution flag) indicating that the abnormal pixel detection has been performed to ON (Step S**306**). The abnormal pixel detection execution flag is held in the RAM **303**.

[0118] After that, the CPU **301** determines whether or not the reading start instruction has been acquired similarly to the processing step of Step S**301** (Step S**307**). In a case where no reading start instruction is acquired (Step S**307**: N), the CPU **301** determines whether or not the original has been removed (Step S**308**). In a case where the original has been removed (Step S**308**: Y), the process returns to the processing step of Step S**301**, and the CPU **301** determines whether or not the reading start instruction has been acquired. In a case where the original has not been removed (Step S**308**: N), the process returns to the processing step of Step S**307**, and the CPU **301** determines whether or not the reading start instruction has been acquired.

[0119] In a case where the reading start instruction is acquired from the CPU **311** in the processing step of Step S**301** or the processing step of Step S**307** (Step S**301**: Y, or Step S**307**: Y), the CPU **301** determines whether or not the abnormal pixel detection execution flag stored in the RAM **303** is ON (Step S**309**). In a case where the abnormal pixel detection execution flag is not ON (Step S**309**: N), the CPU **301** performs the abnormal pixel detection processing because the abnormal pixel detection processing for the front-surface white reference member **103** is not performed (Step S**310**). In a case where the abnormal pixel detection execution flag is ON (Step S**309**: Y), or after the abnormal pixel detection processing is executed, the CPU **301** performs the abnormal pixel correction processing described above (Step S**311**).

[0120] The abnormal pixel detection processing and the abnormal pixel correction processing for the front-surface white reference member **103** are thus ended. After that, the CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** to the reading start position Ps illustrated in FIG. **5**E, and performs reading of the original (Step S**312**). In a case where the original is placed on the original tray **121** of the ADF, the flow reading in the flow reading mode is performed. In a case where the original is placed on the platen **101**, the fixed reading in the fixed reading mode is performed.

[0121] Similarly to the processing step of Step S**105**, the CPU **301** stands by until the reading of all of the originals is ended (Step S**313**: N). After the reading of all of the originals is ended (Step S**313**: Y), the CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** to the HP position (P**1**) (Step S**314**). The processing of reading the original is thus ended.

[0122] In the fourth embodiment described above, the front-surface white reference member **103** is read while the front surface reading unit **104** is moved at the time of abnormal pixel detection for the white reference member and the time of the abnormal pixel correction for the white reference member. Accordingly, even when an inexpensive white reference member is used, the abnormal pixel of the white reference member can be detected without being affected by the unevenness of the surface of the white reference member. Thus, accurate shading correction can be performed. Further, the abnormal pixel detection for the white reference member is performed in advance at a timing at which the original is placed on the original tray **121** or the platen **101**, and hence the time period required from the original reading start to end can be shortened.

Fifth Embodiment

[0123] A configuration of the automatic original reading apparatus **10** and a configuration of the control system in a fifth embodiment of the present disclosure are similar to those in the first embodiment, and hence description of the configuration of the automatic original reading apparatus **10** and the configuration of the control system is omitted. In the fifth embodiment, the abnormal pixel detection processing is similar to that in the first embodiment or the second embodiment, and hence description thereof is omitted. In the fifth embodiment, the abnormal pixel correction processing is similar to that in the first embodiment or the third embodiment, and hence description thereof is omitted. In the fifth embodiment, similarly to the fourth embodiment, the original placement onto the original tray **121** or the original placement onto the platen **101** is detected.

[0124] FIG. **19** is a flow chart for illustrating processing of reading the original in the fifth embodiment. FIG. **19** shows processing of reading one surface (front surface) of the original.

[0125] The CPU **301** waits for the reading start instruction and determines whether the original has been placed similarly to the processing steps of Step S**301** and Step S**302** of FIG. **18** in the fourth embodiment (Step S**401** and Step S**402**). In a case where no reading start instruction is acquired and the original has been placed (Step S**401**: N, and Step S**402**: Y), the CPU **301** performs the abnormal pixel detection processing described above (Step S**403**). After the abnormal pixel detection processing is ended, the CPU **301** performs the abnormal pixel correction processing described above (Step S**404**). The CPU **301** sets a flag (abnormal pixel detection execution flag) indicating that the abnormal pixel detection has been performed to ON (Step S**405**). The abnormal pixel detection execution flag is held in the RAM **303**.

[0126] After that, the CPU **301** determines whether or not the reading start instruction has been acquired similarly to the processing step of Step S**401** (Step S**406**). In a case where no reading start instruction is acquired (Step S**406**: N), the CPU **301** determines whether or not the original has been removed (Step S**407**). In a case where the original has not been removed (Step S**407**: N), the CPU **301** determines whether or not a predetermined time period has elapsed from when the abnormal pixel detection execution flag is set to ON (Step S**408**). The predetermined time period is, for example, 15 seconds. In a case where the predetermined time period has not elapsed (Step S**408**: N), the process returns to the processing step of Step S**406**, and the CPU **301** determines whether or not the reading start instruction has been acquired.

[0127] In a case where the predetermined time period has elapsed (Step S**408**: Y), or the original has been removed (Step S**407**: Y), the CPU **301** sets the abnormal pixel detection execution flag to OFF (Step S**409**). That is, the CPU **301** sets, by the processing steps of from Step S**406** to Step S**408**, the abnormal pixel detection execution flag to OFF in a case where no reading start instruction is acquired even after the elapse of the predetermined time period from when the abnormal pixel detection execution flag is set to ON. Further, the CPU **301** sets the abnormal pixel detection execution flag to OFF in a case where the original is removed even before the elapse of the predetermined time period from when the abnormal pixel detection execution flag is set to ON.

[0128] The CPU **301** which has set the abnormal pixel detection execution flag to OFF turns off the LED **105** (Step S**410**), and moves the front surface reading unit **104** to the HP position (P**1**) (Step S**411**). After that, the process returns to the processing step of Step S**401**, and the CPU **301** waits for the reading start instruction.

[0129] In a case where the reading start instruction is acquired from the CPU **311** in the processing step of Step S**401** or the processing step of Step S**406** (Step S**401**: Y, or Step S**406**: Y), the CPU **301** determines whether or not the abnormal pixel detection execution flag stored in the RAM **303** is ON (Step S**420**). In a case where the abnormal pixel detection execution flag is not ON (Step S**420**: N), the CPU **301** determines that the abnormal pixel detection processing and the abnormal pixel correction processing for the front-surface white reference member **103** are not performed, and performs the abnormal pixel detection processing and the abnormal pixel correction processing again (Step S**421** and Step S**422**).

[0130] In a case where the abnormal pixel detection execution flag is ON (Step S**420**: Y), or after the abnormal pixel detection processing and the abnormal pixel correction processing are executed, the CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** to the reading start position Ps, and performs reading of the original (Step S**423**). In a case where the original is placed on the original tray **121** of the ADF, the flow reading in the flow reading mode is performed. In a case where the original is placed on the platen **101**, the fixed reading in the fixed reading mode is performed.

[0131] Similarly to the processing step of Step S**105**, the CPU **301** stands by until the reading of all of the originals is ended (Step S**424**: N). After the reading of all of the originals is ended (Step S**424**: Y), the CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** to the HP position (P**1**) (Step S**425**). The processing of reading the original is thus ended.

[0132] In the fifth embodiment described above, the front-surface white reference member **103** is read while the front surface reading unit **104** is moved at the time of abnormal pixel detection for the white reference member and the time of the abnormal pixel correction for the white reference member. Accordingly, even when an inexpensive white reference member is used, the abnormal pixel of the white reference member can be detected without being affected by the unevenness of the surface of the white reference member. Thus, accurate shading correction can be performed. Further, the abnormal pixel detection and the abnormal pixel correction for the white reference member are performed in advance at a timing at which the original is placed on the original tray **121** or the platen **101**, and hence the time period required from the original reading start to end can be shortened.

Sixth Embodiment

[0133] A configuration of the automatic original reading apparatus **10** and a configuration of the control system in a sixth embodiment of the present disclosure are similar to those in the first embodiment, and hence description of the configuration of the automatic original reading apparatus **10** and the configuration of the control system is omitted. In the sixth embodiment, the abnormal pixel detection processing is similar to that in the first embodiment or the second embodiment, and hence description thereof is omitted. In the sixth embodiment, similarly to the fourth embodiment, the original placement onto the original tray **121** or the original placement onto the platen **101** is detected.
[0134] The abnormal pixel correction processing in the sixth embodiment is described. The abnormal pixel correction processing in the sixth embodiment is executed by any of the two types of processing depending on an execution state of the abnormal pixel detection processing. In a case where the abnormal pixel correction processing is performed subsequently to the abnormal pixel detection processing, the CPU **301** performs the processing of the flow chart illustrated in FIG. **10** in the first embodiment. In a case where the abnormal pixel correction processing is performed alone, the CPU **301** performs the processing of the flow chart illustrated in FIG. **15** in the third embodiment.
[0135] FIG. **20** is a flow chart for illustrating processing of reading the original in the sixth embodiment. FIG. **20** shows processing of reading one surface (front surface) of the original.
[0136] The CPU **301** waits for the reading start instruction and determines whether the original has been placed similarly to the processing steps of Step S**301** and Step S**302** of FIG. **18** in the fourth embodiment (Step S**501** and Step S**502**). In a case where no reading start instruction is acquired and the original has been placed (Step S**501**: N, and Step S**502**: Y), the CPU **301** performs the abnormal pixel detection processing described above (Step S**503**). After the abnormal pixel detection processing is ended, the CPU **301** performs the abnormal pixel correction processing illustrated in FIG. **10** (Step S**504**). The CPU **301** sets a flag indicating that the abnormal pixel detection has been performed (abnormal pixel detection execution flag) and a flag indicating that the abnormal pixel correction has been performed (abnormal pixel correction execution flag) to ON (Step S**505**). The abnormal pixel detection execution flag and the abnormal pixel correction execution flag are held in the RAM **303**.
[0137] After that, the CPU **301** determines whether or not the reading start instruction has been acquired similarly to the processing step of Step S**501** (Step S**506**). In a case where no reading start instruction is acquired (Step S**506**: N), the CPU **301** determines whether or not the original has been removed (Step S**507**). In a case where the original has not been removed (Step S**507**: N), the CPU **301** determines whether or not a predetermined time period has elapsed from when the abnormal pixel detection execution flag and the abnormal pixel correction execution flag are set to ON (Step S**508**). The predetermined time period is, for example, **15** seconds. In a case where the predetermined time period has not elapsed (Step S**508**: N), the process returns to the processing step of Step S**506**, and the CPU **301** determines whether or not the reading start instruction has been acquired.
[0138] In a case where the predetermined time period has elapsed (Step S**508**: Y), or the original has been removed (Step S**507**: Y), the CPU **301** sets the abnormal pixel correction execution flag to OFF (Step S**509**). That is, the CPU **301** sets, by the processing steps of from Step S**506** to Step S**508**, the abnormal pixel correction execution flag to OFF in a case where no reading start instruction is acquired even after the elapse of the predetermined time period from when the abnormal pixel correction execution flag is set to ON. Further, the CPU **301** sets the abnormal pixel correction execution flag to OFF in a case where the original is removed even before the elapse of the predetermined time period from when the abnormal pixel correction execution flag is set to ON.
[0139] The CPU **301** which has set the abnormal pixel correction execution flag to OFF turns off the LED **105** (Step S**510**), and moves the front surface reading unit **104** to the HP position (P**1**) (Step S**511**). After that, the process returns to the processing step of Step S**501**, and the CPU **301**

waits for the reading start instruction.

[0140] In a case where the reading start instruction is acquired from the CPU **311** in the processing step of Step S**501** or the processing step of Step S**506** (Step S**501**: Y, or Step S**506**: Y), the CPU **301** determines whether or not the abnormal pixel detection execution flag stored in the RAM **303** is ON (Step S**520**). In a case where the abnormal pixel detection execution flag is not ON (Step S**520**: N), the CPU **301** determines that the abnormal pixel detection processing and the abnormal pixel correction processing for the front-surface white reference member **103** are not performed, and performs the abnormal pixel detection processing and the abnormal pixel correction processing again (Step S**521** and Step S**522**). In this case, the abnormal pixel detection processing and the abnormal pixel correction processing are successively performed, and hence the CPU **301** performs the abnormal pixel correction processing illustrated in FIG. **10**.

[0141] In a case where the abnormal pixel detection execution flag is ON (Step S**520**: Y), the CPU **301** determines whether or not the abnormal pixel correction execution flag stored in the RAM **303** is ON (Step S**523**). In a case where the abnormal pixel correction execution flag is not ON (Step S**523**: N), the CPU **301** determines that the abnormal pixel correction processing for the front-surface white reference member **103** is not performed, and performs the abnormal pixel correction processing again (Step S**524**). In this case, the abnormal pixel correction processing is performed alone, and hence the CPU **301** performs the abnormal pixel correction processing illustrated in FIG. **15**.

[0142] In a case where the abnormal pixel correction execution flag is ON (Step S**523**: Y), after the abnormal pixel correction processing of Step S**522** is executed, or after the abnormal pixel correction processing of Step S**524** is executed, the execution of the abnormal pixel detection processing and the abnormal pixel correction processing is finished. In this case, the CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** to the reading start position Ps, and performs reading of the original (Step S**525**). In a case where the original is placed on the original tray **121** of the ADF, the flow reading in the flow reading mode is performed. In a case where the original is placed on the platen **101**, the fixed reading in the fixed reading mode is performed.

[0143] Similarly to the processing step of Step S**105**, the CPU **301** stands by until the reading of all of the originals is ended (Step S**526**: N). After the reading of all of the originals is ended (Step S**526**: Y), the CPU **301** drives the optical system motor **225** to move the front surface reading unit **104** to the HP position (P**1**) (Step S**527**). The processing of reading the original is thus ended.

[0144] In the sixth embodiment described above, the front-surface white reference member **103** is read while the front surface reading unit **104** is moved at the time of abnormal pixel detection for the white reference member and the time of the abnormal pixel correction for the white reference member. Accordingly, even when an inexpensive white reference member is used, the abnormal pixel of the white reference member can be detected without being affected by the unevenness of the surface of the white reference member. Thus, accurate shading correction can be performed. Further, the abnormal pixel detection and the abnormal pixel correction for the white reference member are performed in advance at a timing at which the original is placed on the original tray **121** or the platen **101**, and hence the time period required from the reading start to end can be shortened.

[0145] In the first to sixth embodiments, the CPU **301** causes the image processor **306** to perform shading correction of the reading data obtained by reading the original, based on the shading correction data. In this manner, even when a foreign matter adheres to the front-surface white reference member **103**, the shading correction can be accurately performed, and the original can be read with high accuracy.

Image Forming System

[0146] FIG. **21** is a configuration view of an image forming system including the automatic original reading apparatus **10** described in any one of the first to sixth embodiments, an image forming apparatus, and the operation unit **90**. In an image forming system **1**, the reader **40** is provided on an image forming apparatus **50**, and the ADF **20** is provided on the reader **40**. The operation unit **90** is provided on the front side of the automatic original reading apparatus **10** and the image forming apparatus **50**. With the image forming system **1** described above, a high-functional image forming apparatus such as a copying machine, a multifunction machine, or an MFP is achieved.

[0147] In a case where the copying of the original is performed, the image data generated by reading the original by the reader **40** is transmitted to the image forming apparatus **50**. This image data has been subjected to shading correction through use of the shading correction data. The image forming apparatus **50** forms an image onto a sheet based on the image data acquired from the reader **40**. The image forming apparatus **50** performs image formation onto the sheet with a system normally used for image formation, such as an electrographic system or an inkjet system. The time period required from reading start to end of the reader **40** is shortened, and hence the first copy output time is reduced.

[0148] The image forming apparatus **50** may be connected to an external apparatus via a predetermined network. In this case, the image forming apparatus **50** may transmit the image data acquired from the reader **40** to the external apparatus.

[0149] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

[0150] This application claims the benefit of Japanese Patent Application No. 2024-020324, filed Feb. 14, 2024, which is hereby incorporated by reference herein in its entirety.

Claims

1. An image reading apparatus comprising: a reference member; a reader configured to read one of an original or the reference member; a mover configured to move the reader to a first region in which the original is read and a second region in which the reference member is read in a conveying direction of the original; and at least one processor configured to perform shading correction, wherein the at least one processor is configured to: control the reader to move from outside of the second region to inside of the second region in the conveying direction to perform a first reading operation of reading the reference member within the second region; control the reader to move, after the first reading operation is performed, from the outside of the second region to the inside of the second region again and cause the reader to perform a second reading operation of reading the reference member within the second region; and perform the shading correction using a first reading result read in the first reading operation and a second reading result read in the second reading operation.

2. The image reading apparatus according to claim 1, wherein the at least one processor is configured to: detect an abnormal pixel in which the first reading result is an abnormal value based on a predetermined threshold value and the first reading result obtained by causing the reader to read different positions within the second region of the reference member a plurality of times by the first reading operation; generate shading correction data by correcting the abnormal pixel based on the second reading result obtained by causing the reader to read different positions within the second region of the reference member a plurality of times by the second reading operation; and perform the shading correction of a reading result of the original obtained by the reader through use of the shading correction data.

3. The image reading apparatus according to claim 2, wherein the at least one processor is configured to detect the abnormal pixel based on second data obtained by performing, through use of first data obtained from a reading result obtained by causing the reader to read a first position outside of the second region of the reference member, the shading correction of the first reading result obtained by causing the reader to read the different positions of the second region of the reference member a plurality of times.

4. The image reading apparatus according to claim 3, wherein the at least one processor is configured to detect the abnormal pixel by comparing the second data and the predetermined threshold value with each other, the predetermined threshold value being an average value of reading results of pixels in a reading result obtained by causing the reader to read the inside of the second region of the reference member a plurality of times.

5. The image reading apparatus according to claim 4, wherein the at least one processor is configured to divide one line of the reading result obtained by causing the reader to read the inside of the second region of the reference member a plurality of times into a plurality of sections, and set an average value of reading results of pixels in each of the plurality of sections as the predetermined threshold value of the each of the plurality of sections.

6. The image reading apparatus according to claim 2, wherein the at least one processor is configured to generate the shading correction data by correcting the abnormal pixel based on the second reading result of a pixel adjacent to the abnormal pixel in a direction of one line.

7. The image reading apparatus according to claim 2, wherein the at least one processor is configured to detect the abnormal pixel in response to acquisition of an instruction to start reading of the original, and correct the abnormal pixel after the abnormal pixel is detected.

8. The image reading apparatus according to claim 2, wherein the at least one processor is configured to detect the abnormal pixel before an instruction to start reading of the original is acquired, and correct the abnormal pixel after the instruction to start reading is acquired.

9. The image reading apparatus according to claim 8, wherein the at least one processor is configured to detect the abnormal pixel in a case where the image reading apparatus is started up.

10. The image reading apparatus according to claim 8, further comprising: a placement portion on which the original is to be placed; and an original detection sensor configured to detect the original placed on the placement portion, wherein the at least one processor is configured to detect the abnormal pixel in a case where the original detection sensor detects the original.

11. The image reading apparatus according to claim 10, wherein the placement portion is a tray provided in a conveyance portion configured to convey the original to a reading position of the reader, and wherein the original detection sensor is configured to detect the original placed on the tray.

12. The image reading apparatus according to claim 10, wherein the placement portion is a platen, and wherein the original detection sensor is configured to detect the original placed on the platen.

13. The image reading apparatus according to claim 10, further comprising a timer configured to count an elapsed time period from previous detection of the abnormal pixel, wherein the at least one processor is configured to detect the abnormal pixel in a case where the original detection sensor detects the original and a predetermined time period has elapsed from the previous detection of the abnormal pixel.

14. The image reading apparatus according to claim 2, wherein the at least one processor is configured to detect the abnormal pixel before an instruction to start reading of the original is acquired, and correct the abnormal pixel before the instruction to start reading is acquired.

15. The image reading apparatus according to claim 14, further comprising: a placement portion on which the original is to be placed; and an original detection sensor configured to detect the original placed on the placement portion, wherein the at least one processor is configured to detect the abnormal pixel in a case where the original detection sensor detects the original, and correct the abnormal pixel after the abnormal pixel is detected.

16. The image reading apparatus according to claim 15, further comprising a timer configured to count an elapsed time period from previous detection of the abnormal pixel, wherein the at least one processor is configured to detect the abnormal pixel again in a case where a predetermined time period has elapsed from the previous detection of the abnormal pixel and an instruction to start reading of the original is acquired, and wherein the at least one processor is configured to correct the abnormal pixel again in a case where the predetermined time period has elapsed from the previous detection of the abnormal pixel and the instruction to start reading of the original is acquired.

17. The image reading apparatus according to claim 15, further comprising a timer configured to count an elapsed time period from previous detection of the abnormal pixel, wherein the at least one processor is configured to correct the abnormal pixel again in a case where a predetermined time period has elapsed from previous correction of the abnormal pixel and an instruction to start reading of the original is acquired.

18. An image forming system comprising: an image reading apparatus; and an image forming apparatus configured to form an image onto a sheet based on image data generated by performing shading correction of a reading result of the original by the image reading apparatus, wherein the image reading apparatus includes: a reference member; a reader configured to read one of an original or the reference member; a mover configured to move the reader to a first region in which the original is read and a second region in which the reference member is read in a conveying direction of the original; and at least one processor configured to perform the shading correction, and wherein the at least one processor is configured to: control the reader to move from outside of the second region to inside of the second region in the conveying direction to perform a first reading operation of reading the reference member within the second region; control the reader to move, after the first reading operation is performed, from the outside of the second region to the inside of the second region again and cause the reader to perform a second reading operation of reading the reference member within the second region; and perform the shading correction using a first reading result read in the first reading operation and a second reading result read in the second reading operation.