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(54) **PAPER SHEET DETECTION DEVICE, PAPER SHEET PROCESSING APPARATUS, AND PAPER SHEET DETECTION METHOD**

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UND PAPIERBOGENNACHWEISVERFAHREN

DISPOSITIF DE DÉTECTION DE FEUILLES DE PAPIER, APPAREIL DE TRAITEMENT DE FEUILLES
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Description

TECHNICAL FIELD

[0001] The present invention relates to sheet detection devices, sheet handling devices, and sheet detection methods. The present invention specifically relates to a sheet detection device, a sheet handling device, and a sheet detection method suitable for detecting the external shape and/or the presence or absence of a sheet.

BACKGROUND ART

[0002] Sheets such as banknotes (printed money), gift vouchers, and checks have a variety of security characteristics for anti-counterfeiting. For example, although paper made of vegetable fibers is usually used for sheets, paper made of synthetic fibers or a polymer sheet made of synthetic resin may be used in order to improve the properties such as durability, water resistance, and security. Banknotes made of polymer sheets are called polymer banknotes. Polymer banknotes having a transparent portion such as a clear window (transparent window) are difficult to counterfeit.

[0003] For collection of information such as the external shape and the presence or absence of a sheet, an optical sensor such as an optical line sensor is usually used. A transparent portion transmits light emitted from the optical sensor, and a sheet having a transparent portion may therefore need to undergo different processes from a common sheet having no transparent portion.

[0004] For example, Patent literature 1 discloses irradiating one surface of a sheet with light beams having different wavelengths from two different light sources and receiving light beams of such irradiation passed through the sheet to achieve detection of a watermarked image on the sheet and detection of the shape and a defect at the same stage.

[0005] Patent Literature 2 discloses a banknote image detection device which enables cost reduction. The device includes detection units arranged to sandwich a banknote conveying passage therebetween, with each detection unit including an image detecting sensor and a light emitting means.

CITATION LIST

- Patent Literature

[0006]

Patent Literature 1: JP 2013-77163 A
Patent Literature 2: JP 2004-355264 A

[0007] DE 10 2013 006 925 A1 relates to a device and method for examining value documents, in particular banknotes, and value document processing system. The document relates to a device and to a method for exam-

ining value documents, in particular banknotes, and to a value document processing system having at least one sensor for detecting an electromagnetic radiation transmitted by a value document and generating corresponding first sensor signals and for detecting an electromagnetic radiation remitted by the value document and producing corresponding second sensor signals and an evaluation device for examining whether the value document has a foreign object, in particular an adhesive strip, taking into account first and second sensor signals which correspond to the electromagnetic radiation transmitted or remitted in each case in the region of the edge of the value document. The device prevents deformations in the region of the edge of value documents from being identified as foreign objects.

[0008] EP 2 993 648 A1 relates to an image acquisition device and image acquisition method. Light is emitted on one side of a paper sheet, which is being transported on a transport path, from a first light source, and light is emitted on other side of the paper sheet from a second light source and a fourth light source. A first light receiving sensor receives a first reflected light, which is the light emitted by the first light source and reflected from the one side of the paper sheet. A second light receiving sensor receives a second reflected light, which is the light emitted by the second light source and the fourth light source and reflected from the other side of the paper sheet, and receives a transmitted light that is the light emitted by the first light source and that has passed through the paper sheet. With this, satisfactory reflection image and transmission image of the paper sheet can be acquired while realizing the downsizing of the device.

[0009] EP 2 525 332 A1 relates to a paper sheet identification device and paper sheet identification method. A paper-sheet recognition apparatus includes a paper-sheet information acquisition unit that acquires paper-sheet information including an image data of the paper sheet; a candidate narrowing-down unit that narrows down a number of type candidates of the paper sheet to a small number of types based on the image data included in the paper-sheet information; a type determining unit that determines one type from the type candidates narrowed down by the candidate narrowing-down unit based on the image data included in the paper-sheet information; authenticity recognition unit that recognizes authenticity of the paper sheet as to each type candidate narrowed down by the candidate narrowing-down unit; an execution instructing unit that issues an instruction such that the type determining unit and the authenticity recognition unit are operated concurrently; and a final judgment unit that performs a final judgment on the paper sheet by combining the type determined by the type determining unit and authenticity recognition result corresponding to the type from among authenticity recognition results of the candidate types recognized by the authenticity recognition unit.

- Technical Problem

[0010] For recognition of information such as the type and the authenticity of a sheet with the use of an image of the sheet, the image is usually taken by an image sensor module including an optical line sensor. The light, such as infrared light, emitted from a light source of the image sensor module passes through a transparent portion of a sheet. Thus, also in this case, a sheet having a transparent portion needs to undergo different processes from a common sheet having no transparent portion.

[0011] Specifically, in processing of recognizing a sheet, the external shape (outline) of a sheet is first detected (extracted) from the image data acquired by an image sensor module. In other words, although the image taken by the image sensor module includes not only the sheet but also the background thereof, a region corresponding to the sheet in the overall image needs to be specified and the external shape of the region needs to be extracted. Still, in the case of a sheet having a transparent portion, a region corresponding to the sheet may not be correctly extracted from the overall image.

[0012] For example, when a transmission image of a banknote having transparent portions is taken using infrared light, the infrared light may pass through the transparent portions. This may cause assimilation of transparent regions 1001 and 1002, which correspond to the transparent portions, in a medium region 1000, which corresponds to the banknote, into a background region 1003, as illustrated in Fig. 14(a). Then, as illustrated in Fig. 14(b), when the transmission image is processed such that multiple points on the edges of the medium region 1000 are detected as edge computed points (white dots and black dots in Fig. 14(b)) corresponding to the edges of the banknote, these edge computed points may include some edge computed points (the black dots in Fig. 14(b)) inside the actual edges of the banknote. Based on these inappropriate edge computed points, a region 1004 within the medium region 1000 may be computed as the banknote, as illustrated in Fig. 14(c).

[0013] To solve this issue, improving the algorithm of sheet shape extraction processing may be considered. Still, there is a variety of sizes and positions of clear windows, so that such improvement in the algorithm may have difficulty in solving the issue and may possibly fail to treat a sheet having an unknown transparent portion.

[0014] When the external shape of a sheet is not correctly extracted, the sheet size such as the length (e.g., the length of a banknote) and the parameters relating to the state of a sheet under transport such as the skewing angle may not be correctly computed. This may possibly cause a reduction in passage of sheets due to rejection that is caused by incorrect computation of the positional information for recognizing sheets and cause miscalculation due to misrecognition.

[0015] Also, in the case of using the image sensor module as a tracking sensor for detecting the presence or absence of a sheet under transport, the presence of a

transparent portion at an edge of a banknote as illustrated in Fig. 14(a), for example, may cause a failure in detecting the edge, possibly causing incorrect detection of passing of the banknote.

[0016] Further, even when a sheet having a transparent portion is irradiated with light of different wavelengths as disclosed in Patent Literature 1, transmissive light alone of such light of different wavelengths fails to cause correct detection of the external shape and the presence or absence of a variety of sheets having a transparent portion. For example, even in the case of documents having a clear window, some characteristics of a material thereof enable detection of the clear window from transmissive light alone of different wavelengths. Still, when a certain combination of wavelengths can be used to detect a clear window of a kind of document A of a specific date in a certain country while a different combination of wavelengths can be used to detect a clear window of a kind of document B of a different date in a different country, the combination of wavelengths to be used cannot be fixed in the stage of extracting the external shape at which the kind of document has not yet been determined. Thus, the above technique fails to detect clear windows of every kind of documents of different countries or different dates.

[0017] Patent Literature 2 does not disclose the above technical issue caused by a transparent portion of a sheet, and does not aim to solve the above technical issue.

[0018] It is an object of the present invention to provide an improved and useful sheet detection device in which the above-mentioned problems are eliminated.

[0019] In order to achieve the above-mentioned object, there is provided a sheet detection device according to claim 1. In addition, there is provided a sheet handling device according to claim 9 and a sheet detection method according to claim 10.

[0020] Advantageous embodiments are defined by the dependent claims.

- Solution to Problem

[0021] One aspect of the present invention is a sheet detection device comprising: a first image collection unit configured to collect reflection image data of a sheet under transport on a transport path; a second image collection unit configured to collect transmission image data of the sheet under transport on the transport path; and a sheet detector configured to detect the presence or absence of the sheet based on the reflection image data and the transmission image data.

[0022] In the above aspect of the present invention, the first image collection unit and the second image collection unit may share a light-receiving sensor.

[0023] In the above aspect of the present invention, the first image collection unit and the second image collection unit may share a light source.

[0024] In the above aspect of the present invention,

the sheet detector is configured: to binarize the reflection image data and the transmission image data to generate binarized reflection image data and binarized transmission image data, respectively; to execute OR processing on the binarized reflection image data and the binarized transmission image data to generate OR-processed image data; and to detect the external shape of the sheet based on the OR-processed image data.

[0025] In the above aspect of the present invention, the sheet detector is configured to output outline information of an OR-processed image derived from the OR-processed image data.

[0026] In the above aspect of the present invention, the sheet detector may be configured: to generate a 2D reflection image and a 2D transmission image from the reflection image data and the transmission image data, respectively; and to detect at least one of the external shape or the presence or absence of the sheet based on the 2D reflection image and the 2D transmission image.

[0027] In the above aspect of the present invention, the sheet detector may be configured to detect at least one of the external shape or the presence or absence of the sheet based on data of each line of the reflection image data and data of each line of the transmission image data corresponding to the data of each line of the reflection image data.

[0028] In the above aspect of the present invention, the first image collection unit and the second image collection unit may be configured to apply light of multiple wavelengths including infrared light to the sheet.

[0029] In the above aspect of the present invention, the sheet may have a base material that is a polymer or a composite of paper and a polymer.

[0030] Another aspect of the present invention is a sheet handling device comprising the sheet detection device.

[0031] Still another aspect of the present invention is a sheet detection method according to claim 11 and comprising: a first image collection step of collecting reflection image data of a sheet under transport on a transport path; a second image collection step of collecting transmission image data of the sheet under transport on the transport path; and a sheet detection step of detecting at least one of the external shape or the presence or absence of the sheet based on the reflection image data and the transmission image data.

- Advantageous Effects of Invention

[0032] The sheet detection device, the sheet handling device, and the sheet detection method of the present invention can improve the precision of detecting at least one of the external shape or the presence or absence of a sheet having a transparent portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033]

Fig. 1 is a schematic view for illustrating the summary of a banknote detection method of Embodiment 1. Fig. 2 is a schematic view for illustrating a method for detecting the shape of a banknote from a reflection image alone.

Fig. 3 is an exemplary processing flow chart of the banknote detection method of Embodiment 1.

Fig. 4 includes schematic views of the structure of a sensor unit of Embodiment 1; Fig. 4(a) is a side view and Fig. 4(b) is a plan view of the transport surface observed in the direction of the arrow in the Fig. 4(a). Fig. 5 is a schematic side view of an exemplary structure of an image sensor module of Embodiment 1. Fig. 6 is a schematic side view of another exemplary structure of the image sensor module of Embodiment 1.

Fig. 7 is a block diagram of a structure relating to control of a banknote recognition device of Embodiment 1.

Fig. 8 is a view for illustrating a data processing method in the banknote detection device of Embodiment 1, illustrating a method of OR processing binarized reflection image data and binarized transmission image data to generate OR-processed image data.

Fig. 9 is a view for illustrating the data processing method in the banknote detection device of Embodiment 1, illustrating a method for detecting the left and right edges of a banknote from the OR-processed image data.

Fig. 10 is a view for illustrating the data processing method in the banknote detection device of Embodiment 1, illustrating a method for detecting the upper and lower edges of a banknote from the OR-processed image data.

Fig. 11(a) is a schematic perspective view of the appearance of a banknote handling device of Embodiment 1 and Fig. 11(b) is a schematic cross-sectional view of the structural outline inside the banknote handling device of Embodiment 1.

Fig. 12 is a schematic perspective view of the appearance of another banknote handling device of Embodiment 1.

Fig. 13 is a schematic plan view of an exemplary banknote having a transparent portion.

Figs. 14(a) to 14(c) are schematic plan views of transmission images of a banknote taken by an image sensor module.

DESCRIPTION OF EMBODIMENTS

[0034] Preferred embodiments of the sheet detection device, the sheet handling device, and the sheet detection method of the present invention are described below with reference to the drawings. Examples of the sheet to be detected in the present invention include banknotes, checks, gift vouchers, bills, ledgers, documents of value, and card-like media. In the following, the present invention is described with a banknote detection device, a bank-

knote recognition device, a banknote handling device, and a banknote detection method taken as examples. Described in the following are examples of a banknote detection device, a banknote recognition device, a banknote handling device, and a banknote detection method.

(Banknote to be handled)

[0035] A banknote to be handled in the present embodiment is described here. The banknote to be handled is preferably a polymer banknote having a transparent portion such as a clear window that transmits light such as infrared light applied. In the present embodiment, a banknote having no transparent portion, such as a paper banknote, may also be handled. The transparent portion is preferably made from a synthetic resin (polymer). Thus, the banknote to be handled is preferably formed from a polymer sheet. The banknote to be handled may also be a sheet (hybrid banknote) whose transparent portion is formed from a polymer sheet and whose opaque portion is formed from paper made of vegetable fibers or synthetic fibers. As described here, the base material of the banknote to be handled is preferably a polymer or a composite of paper and a polymer. The transparent portion may partially include an optically variable device (OVD) such as rainbow hologram.

[0036] Fig. 13 illustrates a banknote BN1 that is an exemplary banknote to be handled. The banknote BN1 has a transparent portion T1 on each edge in the longitudinal direction. For example, the five pound banknote issued by the Clydesdale Bank in Scotland is similar to this banknote BN1. In the present embodiment, the devices and the method are configured to collect the image data of a banknote BN1 by an image sensor module 15 arranged in the direction perpendicular to the transport direction (the direction from the head to the bottom of the paper in Fig. 13). Based on two types of images taken by the image sensor module 15, the positions of the edges of the banknote BN1 are extracted and the external shape (outline) of the banknote BN1 is detected (extracted). In the example illustrated in Fig. 13, the banknote is long-edge fed. Alternatively, a banknote may be short-edge fed.

[0037] The banknote detection device, the banknote recognition device, the banknote handling device, and the banknote detection method of the present embodiment described hereinbelow are configured to highly precisely detect the external shapes of a variety of banknotes having a transparent portion.

(Summary of banknote detection method)

[0038] The summary of a banknote detection method of the present embodiment is first described. As illustrated in Fig. 1, in the present embodiment, a binarized image is generated from not only a 2D transmission image (hereinafter, also simply referred to as a transmission image) derived from transmission image data but also a

2D reflection image (hereinafter, also simply referred to as a reflection image) derived from reflection image data. For example, when a banknote having transparent portions at edges is imaged, the following case may occur.

5 That is, as illustrated in Fig. 1, in a region corresponding to the transparent portions in a transmission image, light transmissive regions 1a are present at edges of a medium region 1b corresponding to the banknote and are assimilated to a background region 1c, while in the region corresponding to the transparent portion in a reflection image, light reflective regions 2a are present at edges of a medium region 2b and are not assimilated to a background region 2c. As a result, in the binarized image generated from the transmission image and the reflection image, the edges of a medium-present region 3a where the medium is determined to be present can correctly reflect the edges of a medium region 3b. Thus, detecting the external shape of a banknote based on a binarized image generated from a transmission image and a reflection image can increase the chance of correctly extracting the external shape of even a banknote having a transparent portion at an edge.

[0039] In the case of extracting the shape of a banknote from a reflection image alone, the following case may occur. That is, when an ink that absorbs irradiated light is present at an edge of a banknote, an ink region 2d looks dark in the reflection image and an ink region 4d is assimilated to a background region 4c in the binarized image, which may possibly cause incorrect extraction of the external shape of the banknote, as illustrated in Fig. 2.

[0040] An exemplary processing flowchart is described with reference to Fig. 3. In the example illustrated in Fig. 3, the presence or absence of a banknote (medium) is first detected based on a transmission image acquired by the image sensor module 15 (step S1). Specifically, the transmission image is binarized based on a predetermined threshold to generate a binarized transmission image. In other words, the pixel values of transmission image data are compared with the predetermined threshold; the pixels with a pixel value of lower than the threshold are determined as medium-present, and the pixel data thereof are replaced by 1 (white), while the pixels with a pixel value of not lower than the threshold are determined as medium-absent, and the pixel data thereof are replaced by 0 (black).

[0041] Next, the presence or absence of the banknote (medium) is detected based on a reflection image acquired by the image sensor module 15 (step S2). Specifically, the reflection image is binarized based on a predetermined threshold to generate a binarized reflection image. In other words, the pixel values of reflection image data are compared with the predetermined threshold; the pixels with a pixel value of not lower than the threshold are determined as medium-present, and the pixel data thereof are replaced by 1 (white), while the pixels with a pixel value of lower than the threshold are determined as medium-absent, and the pixel data thereof are replaced by 0 (black).

[0042] The step S1 and the step S2 may be processed in the reversed order, or may be processed simultaneously.

[0043] Next, a binarized image is generated based on the binarized transmission image acquired in the step S1 and the binarized reflection image acquired by the step S2 (step S3). Specifically, the binarized transmission image and the binarized reflection image are OR-processed. In other words, the corresponding pixels of the binarized transmission image and the binarized reflection image are compared; for the banknote-present (white) pixels in at least one of the images, the pixel data are set to 1 (white), while for the banknote-absent (black) pixels in both images, the pixel data are set to 0 (black). Thereby, an OR-processed image (binarized image) is generated.

[0044] Finally, the external shape of the banknote is extracted based on the OR-processed image acquired in the step S3 (step S4). Specifically, a region (partial image region) corresponding to the banknote in the whole OR-processed image including the banknote and the background thereof is specified, and the external shape (outline) of this region is extracted.

[0045] As described above, in the present embodiment, not only a transmission image but also a reflection image is used. Thus, even the pixels determined as medium-absent in the transmission image are eventually determined as medium-present when the pixels are determined as medium-present in the reflection image. Conversely, even the pixels determined as medium-absent in the reflection image are eventually determined as medium-present when the pixels are determined as medium-present in the transmission image. In other words, the transmission image and the reflection image are complementary to each other for extraction of the external shape of a banknote. This can improve the precision of extracting the external shape of a banknote having a transparent portion, and can increase the chance of correctly extracting the external shape of even a banknote having a transparent portion at an edge.

(Structure of sensor unit)

[0046] With reference to Fig. 4, the structure of a sensor unit 10 that is a main part of a banknote recognition device of the present embodiment is described. The sensor unit 10 has a structure in which a photo sensor 13a, the image sensor module 15, a thickness detection sensor 17, a magnetic sensor module 19, and a photo sensor 13b are arranged in line along the transport path 12 on which banknotes BN are transported. The image sensor module 15, the thickness detection sensor 17, and the magnetic sensor module 19 are sufficiently long relative to the width W of the transport path 12 in the direction perpendicular to the transport direction of banknotes BN, i.e., the main scanning direction, and thus can detect the entire surface of a banknote BN. The transport direction of banknotes BN corresponds to the sub-scanning direc-

tion. The sensor unit 10 is provided with a transport mechanism 11 so as to move a banknote BN in the transport path 12. The transport mechanism 11 used may be, but is not limited to, one in which a roller, a belt, or the like is driven by a driver such as a motor. The transport mechanism 11 may be connected with an amount-of-rotation detector such as a rotary encoder, although not illustrated. This enables detection of the distance of transporting a banknote BN from the detected amount of rotation. During transport of a banknote BN by the transport mechanism 11, the image sensor module 15 acquires the image information of the banknote BN. The external shape of the banknote BN is detected based on the acquired image information. The banknote BN may have a transparent portion T that transmits light applied in the image sensor module 15.

[0047] The photo sensor 13a detects banknotes BN successively transported to the sensor unit 10 and generates banknote detection signals each for determining the timing of starting detection of a banknote BN by the sensor unit 10. In contrast, the photo sensor 13b detects passing of a banknote BN. In the reverse transport direction of banknotes BN, the photo sensor 13b detects arrival of a banknote BN and the photo sensor 13a detects passing of a banknote BN. The photo sensors 13a and 13b used are light-reflective or light-transmissive photo sensors. Instead of the photo sensors 13a and 13b, sensors that mechanically detect passing of a banknote BN may be provided.

[0048] The thickness detection sensor 17 detects the thickness of a banknote BN. An example of the thickness detection sensor 17 is one detecting the displacement of rollers facing across the transport path 12 during passing of a banknote BN by sensors provided for the respective rollers.

[0049] The magnetic sensor module 19 is used to detect the magnetic information contained in a banknote BN under transport on the transport path 12. The magnetic sensor module 19 detects the magnetic information such as a security thread that is a metal or resin narrow band-shaped article or a magnetic ink printed on a banknote BN. The magnetic sensor module 19 is preferably a magnetic sensor in which magnetic detection elements (magnetic heads) are arranged in line.

[0050] The image sensor module 15 includes an optical line sensor. For example, it includes a light-receiving sensor (image sensor) in which imaging elements such as CCD or CMOS are arranged in line and imaging optical systems such as a light source and a lens. The image sensor module 15 detects the image data of a banknote BN under transport on the transport path. The image data may be in an imaged form as described above, or may be in the form of combination of non-imaged coordinates and measured values. The image data used may include transmission image data (transmissive light image data) generated from the intensity distribution of light passed through a banknote BN and reflection image data (reflective light image data) generated from the intensity distri-

bution of light reflected on the banknote BN. The reflection image data used may include at least one of front reflection image data based on the light reflected on the front surface of the banknote BN or back reflection image data based on the light reflected on the back surface of the banknote BN. The transmission image data alone is commonly used for detection of the external shape of a banknote BN. Still, in the present embodiment, the transmission image data and the reflection image data are used. The wavelength of light used for acquisition of image data (imaging) may appropriately be selected in accordance with the banknote BN to be imaged. For example, visible light such as single color light of red, green, or blue or white light, infrared light, or ultraviolet light may be used. If necessary, light beams of different spectra may be used to image multiple times. In this case, light beams of different spectra may be applied one by one to a banknote BN. The front reflection image data, the back reflection image data, and the transmission image data each may include multiple sets of image data imaged by light beams of different spectra. For the reflection image data, infrared light is suitable to detect the external shape of a banknote BN and infrared light reflection image data are preferably used. This is because infrared light enables relatively clear imaging of a reflection image even when a banknote BN is soiled or stained, while visible light may provide an entirely black reflection image including the background when a banknote BN is soiled or stained, making it difficult to detect the external shape of the banknote BN. For the transmission image data, the wavelength of light to be used may be, but is not limited to, any of various ones as described above. In order to reduce the cost of an emission element, visible light such as single color light of red, green, or blue or white light, or infrared light is preferred. In other words, visible light transmission image data or infrared light transmission image data are preferred.

[0051] Exemplary structures of the image sensor module 15 are described with reference to Figs. 5 and 6. The image sensor modules 15 illustrated in Figs. 5 and 6 each include an upper unit 15A and a lower unit 15B arranged to face each other across the transport path, and include a first image collection unit 15a and a second image collection unit 15b.

[0052] In the image sensor module 15 illustrated in Fig. 5, the upper unit 15A includes a light source 15Aa that applies light to a banknote BN, a condenser 15Ab that condenses reflective light reflected on the banknote BN or transmissive light passed through the banknote BN, a light-receiving sensor 15Ac that receives reflective light or transmissive light condensed by the condenser 15Ab, a transparent plate 15Ad at a lower portion facing the transport path, and a substrate 15Ae on which the light-receiving sensor 15Ac is mounted. The light-receiving sensor 15Ac includes imaging elements (pixels) arranged in line in the direction (main scanning direction) perpendicular to the transport direction of banknotes BN.

[0053] The lower unit 15B includes a light source 15Ba

that applies light to the banknote BN and a transparent plate 15Bd at an upper portion facing the transport path.

[0054] The first image collection unit 15a includes the light source 15Aa, the condenser 15Ab, and the light-receiving sensor 15Ac. The second image collection unit 15b includes the light source 15Ba, the condenser 15Ab, and the light-receiving sensor 15Ac. As described above, the condenser 15Ab and the light-receiving sensor 15Ac are shared between the first image collection unit 15a and the second image collection unit 15b. In the first image collection unit 15a, the light source 15Aa applies light to a banknote BN, the condenser 15Ab condenses reflective light reflected on the banknote BN, and the light-receiving sensor 15Ac receives reflective light condensed by the condenser 15Ab (first image collection step). The first image collection unit 15a can acquire the reflection image data of the upper surface of the banknote BN. In the second image collection unit 15b, the light source 15Ba applies light to the banknote BN, the condenser 15Ab condenses transmissive light passed through the banknote BN, and the light-receiving sensor 15Ac receives transmissive light condensed by the condenser 15Ab (second image collection step). The second image collection unit 15b can acquire the transmission image data of the banknote BN.

[0055] The image sensor module 15 illustrated in Fig. 5 has excellent cost efficiency because the condenser 15Ab and the light-receiving sensor 15Ac are shared between the first image collection unit 15a and the second image collection unit 15b. However, in this example, the light source 15Aa and the light source 15Ba are controlled to emit light at different timings to shift the imaging timings by the first image collection unit 15a and the second image collection unit 15b. Thus, the position of a banknote BN is slightly different between the timing of acquiring the reflection image data and the timing of acquiring the transmission image data. This may possibly result in a reduced precision of extracting the external shape of a banknote BN in comparison with the example illustrated in Fig. 6.

[0056] In the image sensor module 15 illustrated in Fig. 6, the upper unit 15A includes the light source 15Aa that applies light to a banknote BN, the condenser 15Ab that condenses reflective light reflected on the banknote BN, the light-receiving sensor 15Ac that receives reflective light condensed by the condenser 15Ab, the transparent plate 15Ad at a lower portion facing the transport path, and the substrate 15Ae on which the light-receiving sensor 15Ac is mounted. The light-receiving sensor 15Ac includes imaging elements (pixels) arranged in line in the direction (main scanning direction) perpendicular to the transport direction of banknotes BN.

[0057] The lower unit 15B includes a condenser 15Bb that condenses transmissive light passed through the banknote BN, light-receiving sensors 15Bc that receive transmissive light condensed by the condenser 15Bb, the transparent plate 15Bd at an upper portion facing the transport path, and a substrate 15Be on which the light-

receiving sensor 15Bc is mounted. The light-receiving sensor 15Bc includes imaging elements (pixels) arranged in line in the direction (main scanning direction) perpendicular to the transport direction of banknotes BN.

[0058] The first image collection unit 15a includes the light source 15Aa, the condenser 15Ab, and the light-receiving sensor 15Ac. The second image collection unit 15b includes the light source 15Aa, the condenser 15Bb, and the light-receiving sensor 15Bc. As described above, the light source 15Aa is shared between the first image collection unit 15a and the second image collection unit 15b. In the first image collection unit 15a, the light source 15Aa applies light to a banknote BN, the condenser 15Ab condenses reflective light reflected on the banknote BN, and the light-receiving sensor 15Ac receives reflective light condensed by the condenser 15Ab. The first image collection unit 15a can acquire the reflection image data of the upper surface of the banknote BN (first image collection step). In the second image collection unit 15b, the light source 15Aa applies light to the banknote BN, the condenser 15Bb condenses transmissive light passed through the banknote BN, and the light-receiving sensor 15Bc receives transmissive light condensed by the condenser 15Bb. The second image collection unit 15b can acquire the transmission image data of the banknote BN (second image collection step).

[0059] The image sensor module 15 illustrated in Fig. 6 can simultaneously start imaging by the first image collection unit 15a and imaging by the second image collection unit 15b when the light source 15Aa is allowed to emit light, thereby preventing the difference in the position of a banknote BN between the timing of acquiring the reflection image data and the timing of acquiring the transmission image data. This can result in a higher precision of extracting the external shape of a banknote BN in comparison with the example illustrated in Fig. 5.

[0060] In each of the examples of Figs. 5 and 6, the first image collection unit 15a collects the reflection image data of a banknote BN under transport on the transport path and outputs the collected reflection image data to a sensor information acquirer to be described later, while the second image collection unit 15b collects the transmission image data of a banknote BN under transport on the transport path and outputs the collected transmission image data to the sensor information acquirer to be described later.

[0061] The first image collection unit 15a and the second image collection unit 15b each collect the image data of the whole banknote BN under transport on the transport path line by line. In other words, each image collection unit repeats imaging of a banknote BN under transport in the transport direction (sub-scanning direction) at certain time intervals, with one imaging (exposure of pixel to light) taken as one line, to acquire the image data of the whole banknote BN.

[0062] A banknote BN may be transported in either the face-up state or the face-down state in any orientation. The denomination and the directions, i.e., either the face-

up state or the face-down state and the orientation of a banknote BN are determined by the image information acquired by the image sensor module 15.

5 (Structures of banknote recognition device and banknote detection device)

[0063] With reference to Fig. 7, the structures of controlling the banknote recognition device and the banknote detection device of the present embodiment are described. As illustrated in Fig. 7, a banknote recognition device 100 of the present embodiment includes a sensor group that includes the photo sensors 13a and 13b, the image sensor module 15 (the first image collection unit 15a and the second image collection unit 15b), the thickness detection sensor 17, and the magnetic sensor module 19 as illustrated in Fig. 4, a controller 20 connected with each sensor of the sensor group, and a memory 30 connected with the controller 20.

[0064] The controller 20 composed of a logical device such as a field programmable gate array (FPGA) includes a sensor information acquirer 21, a banknote detector 22, and a recognizer 23.

[0065] The sensor information acquirer 21 has a function of acquiring data relating to a banknote BN from the sensors constituting the sensor group. The sensor information acquirer 21 also appropriately executes a variety of processes, such as amplification, analog-to-digital conversion (digitization), imaging, image correction, and storage to the memory 30, on the reflection image data and the transmission image data input from the first image collection unit 15a and the second image collection unit 15b.

[0066] In order to shorten the times of processing of recognizing the information such as the denomination and processing of extracting the external shape, the sensor information acquirer 21 executes processing (averaging processing) of averaging the output values (pixel values) of multiple consecutive pixels (e.g., six pixels) of the reflection image data of each line for every input of the reflection image data of each line from the first image collection unit 15a, and stores the calculated N average values (wherein N is an integer of 2 or greater) in memory regions corresponding to the 1st channel to the Nth channel of the line. The sensor information acquirer 21 also executes averaging processing on the transmission image data of each line input from the second image collection unit 15b for every input of the transmission image data of each line. For example, when the resolutions in the main scanning direction of the first image collection unit 15a and the second image collection unit 15b are both 200 dpi, the averaged resolutions in the main scanning direction of the reflection image data and the transmission image data are both about 33 dpi.

[0067] When the reflection image data and the transmission image data input from the first image collection unit 15a and the second image collection unit 15b each have a total number of lines of M (wherein M is an integer

of 2 or greater), the averaged reflection image data and transmission image data are each constituted by $N \times M$ pixel data. The arrangement directions of the channels and the lines respectively correspond to the main scanning direction and the sub-scanning direction.

[0068] The following describes extraction of the external shape of a banknote BN based on the averaged reflection image data and transmission image data. Still, this averaging processing may be omitted. In this case, the sensor information acquirer 21 stores the output values (pixel values) of the reflection image data and transmission image data of each line input from the first image collection unit 15a directly in memory regions corresponding to the 1st channel to the N'th channel (wherein N' is an integer satisfying $N' > N$) of the line.

[0069] In the sub-scanning direction, the output of each imaging (exposure of pixel) by the first image collection unit 15a may not be averaged and constitute one pixel value of the reflection image data as it is, or the outputs of multiple consecutive imaging operations (exposure operations of pixel) by the first image collection unit 15a may be averaged for each channel by the sensor information acquirer 21 to constitute one pixel value of the reflection image data. These embodiments may be switched by parameter settings. The same applies to the second image collection unit 15b.

[0070] Regardless of the presence or absence of the averaging processing, the resolutions in the main scanning direction of the reflection image data and the transmission image data are preferably the same as each other, but they are not necessarily the same as each other. The resolutions in the sub-scanning direction of the reflection image data and the transmission image data are also preferably the same as each other, but they are not necessarily the same as each other.

[0071] The banknote detector 22 includes a binarization processor 22a, an OR processor 22b, and an edge extractor 22c, and detects (extracts) the external shape (outline) of a banknote BN based on the reflection image data of the banknote BN acquired by the first image collection unit 15a and the transmission image data of the banknote BN acquired by the second image collection unit 15b (banknote detection step). A banknote detection device 101 of the present embodiment includes the image sensor module 15 (the first image collection unit 15a and the second image collection unit 15b) and the banknote detector 22. The banknote detector 22 is specifically described later.

[0072] The recognizer 23 utilizes the data acquired by the sensor information acquirer 21 to execute recognition processing. The recognizer 23 recognizes at least the denomination and authenticity of a banknote BN.

[0073] The recognizer 23 may have a function of determining the fitness of a banknote BN. In this case, the recognizer 23 has a function of detecting defects such as soil, fold, and tear of a banknote BN and detecting material such as tape attached to a banknote BN based on the thickness of the banknote BN, and thereby deter-

mining whether the banknote BN is processed as a fit note to be reused in the market or as an unfit note unsuitable to circulation in the market.

[0074] When the recognizer 23 uses an image of a banknote BN taken by the image sensor module 15 for recognition of the information such as the denomination, the authenticity, and the fitness, it utilizes the outline information of the banknote BN acquired by the banknote detector 22. For example, based on the outline information of a banknote BN acquired by the banknote detector 22, the recognizer 23 defines a region corresponding to the banknote BN as a recognition target area within the whole image including the banknote BN and the background thereof, divides the image data within the area into blocks, and executes recognition processing by, for example, pattern matching.

[0075] The memory 30 is a memory device including, for example, a semiconductor memory or a hard disk, and stores therein determination data 31 for recognition of the information such as the denomination, the authenticity, and the fitness. The determination data 31 includes a variety of templates 31A and a variety of thresholds 31B. Examples of the templates 31A stored include a reference image for comparison with an image of a banknote BN taken by the image sensor module 15 so as to recognize the information such as the denomination, the authenticity, and the fitness, and a reference waveform and a reference image for comparison with a waveform or an image indicating the magnetic properties acquired from a banknote BN. Examples of the thresholds 31B stored include values for determining a variety of characteristic amounts acquired from a banknote BN so as to recognize the information such as the denomination, the authenticity, and the fitness of the banknote BN or to extract the shape of the banknote BN. Predetermined templates 31A and predetermined thresholds 31B are prepared in advance for the respective denominations of the banknotes BN to be handled by the banknote recognition device 100. The memory 30 also stores setting data of the methods for measuring a variety of data for recognition of a banknote BN. The memory 30 is also used to store the image data and the measured values detected by the sensors and the results of recognizing a banknote BN.

[0076] The processing of recognizing the denomination and authenticity of a banknote BN and the processing of determining the fitness based on defects such as soil, fold, and tear of a banknote BN can be executed by common techniques, and the specifications thereof are not described herein. The following specifically describes extraction of the external shape of a banknote BN achieved as a function of the banknote detection device 101, especially the banknote detector 22.

[0077] The banknote detector 22 executes processing of generating a 2D reflection image and a 2D transmission image respectively from the reflection image data and the transmission image data (optionally the averaged reflection image data and the averaged transmission im-

age data), and of detecting the external shape of a banknote BN based on the 2D reflection image and the 2D transmission image, as described in the summary of the banknote detection method. In contrast, described in the following is the case where the banknote detector 22 executes processing of detecting the external shape of a banknote BN based on the averaged reflection image data and averaged transmission image data of each line.

[0078] First, as illustrated in Fig. 8, after every averaging processing of the reflection image data of each line, the binarization processor 22a binarizes the average value based on a predetermined threshold 31B to generate binarized reflection image data, while simultaneously after every averaging processing of the transmission image data of each line, the binarization processor 22a binarizes the average value based on the predetermined threshold 31B to generate binarized transmission image data (binarization processing step). The binarization processor 22a replaces the banknote-present average values with 1 (white), while replacing the medium-absent average values with 0 (black).

[0079] Next, as illustrated in Fig. 8, after every generation of the binarized reflection image data of each line and of the binarized reflection image data of the corresponding line, the OR processor 22b executes OR processing on the binarized reflection image data and binarized reflection image data of the line to generate OR-processed image data (OR processing step). In other words, the OR processor 22b compares the same channel of the binarized reflection image data and binarized reflection image data of the line; for the channels having a value of 1 (white) in at least one data, the pixel data thereof are set to 1 (white), while for the channels having a value of 0 (black) in both data, the pixel data thereof are set to 0 (black), whereby OR-processed image data are generated.

[0080] Next, as illustrated in Fig. 9, after every generation of the OR-processed image data of each line, the edge extractor 22c detects the both edges of a banknote BN in the OR-processed image data of each line (first edge extraction step). In other words, in the OR-processed image data of each line, the channel of the first medium-present state (= 1) from the minimum channel (1st channel) to the maximum channel (Nth channel) is detected as the left edge channel corresponding to the left edge of the banknote BN relative to the transport direction, while the channel of the last medium-present state (= 1) from the minimum channel (1st channel) to the maximum channel (Nth channel) is detected as the right edge channel corresponding to the right edge of the banknote BN relative to the transport direction. As a result, the channels corresponding to the respective edges (the left and right edges relative to the transport direction) of the banknote BN in the main scanning direction are detected.

[0081] Next, as illustrated in Fig. 10, after generation of the OR-processed image data of every line, the edge extractor 22c detects both edges of the banknote BN in

the OR-processed image data of each channel (second edge extraction step). In other words, in the OR-processed image data of each channel, the line of the first medium-present state (= 1) from the minimum line (1st line) to the maximum line (Mth line) is detected as the front edge line corresponding to the front edge of the banknote BN relative to the transport direction, while the line of the last medium-present state (= 1) from the minimum line (1st line) to the maximum line (Mth line) is detected as the back edge line corresponding to the back edge of the banknote BN relative to the transport direction. As a result, the lines corresponding to the respective edges (the front and back edges relative to the transport direction) of the banknote BN in the sub-scanning direction are detected.

[0082] Then, the banknote detector 22 outputs the outline information of an OR-processed image derived from the OR-processed image data (outline information output step). Specifically, the banknote detector 22 images all OR-processed image data to generate an OR-processed image, and then specifies a region (partial image region) corresponding to the banknote BN in the OR-processed image based on the left edge channel, right edge channel, front edge line, and back edge line corresponding to the upper, lower, left, and right edges of the banknote BN relative to the transport direction, and then extracts the external shape (outline) of the region. Any method may be used to extract the shape of the partial image region from the channels and the lines corresponding to the upper, lower, left, and right edges, and an example thereof may be Hough transform. This is a technique of computing the straight lines passing any of the channels and lines of the respective sides of a banknote BN and determining the four apexes corresponding to the four corners of the banknote BN. Then, the banknote detector 22 outputs the information of the extracted partial image region, i.e., the outline information of the OR-processed image to the recognizer 23.

[0083] The banknote detector 22 may detect the presence or absence of a banknote BN based on the reflection image data and the transmission image data. Thereby, the banknote detector 22 can detect even an edge of a banknote BN at which a transparent portion T is present as described above, and thus can correctly detect passing of the banknote BN. As described above, the banknote detection device 101 can suitably be used as a tracking sensor for detecting the presence or absence of a banknote BN under transport.

(Structure of banknote handling device)

[0084] The banknote handling device of the present embodiment may have a structure illustrated in Fig. 11 or Fig. 12, for example. A banknote handling device 200 illustrated in Fig. 11 includes a hopper 210 capable of supporting a plurality of banknotes, a transport path 211 that transports banknotes supported on the hopper 210, the sensor unit 10 that executes processing of recogniz-

ing banknotes, a stacker 213 that accumulates the banknotes recognized by the sensor unit 10, and a rejecter 214 that accumulates banknotes satisfying predetermined conditions separate from the other banknotes. The use of the sensor unit 10 integrated into such a banknote device 200 enables continuous handling of banknotes supported on the hopper 210 and returning of banknotes determined as any of counterfeit notes, unfit notes, and suspect notes to the rejecter 214 for separation.

[0085] A banknote handling device 300 illustrated in Fig. 12 is a small banknote handling device to be used on a table, and includes a sensor unit (not illustrated) that executes processing of recognizing banknotes, a hopper 301 that supports a stack of banknotes to be handled, two rejecters 302 to which banknotes dispensed from the hopper 301 into a housing 310 are discharged when they are rejected banknotes such as counterfeit notes or suspect notes, an operation unit 303 with which an operator input the instructions, four stackers 306a to 306d that accumulate sorted banknotes whose denomination, authenticity, and fitness are recognized in the housing 310, and a display 305 that displays the information such as the recognition count results of banknotes and the accumulation states of the stackers 306a to 306d. Based on the fitness determination results by the recognition unit, the stackers 306a to 306c stores fit notes and the stacker 306d stores unfit notes among the four stackers 306a to 306d. A method of sorting banknotes into the stackers 306a to 306d may be selected as appropriate.

[0086] The banknote handling device 200 illustrated in Fig. 11 or the banknote handling device 300 illustrated in Fig. 12 may execute two banknote handling processes; in the first handling, the banknote handling device may determine the denomination and the authenticity to sort the banknotes by the denomination, and in the second handling, the banknote handling device may determine the fitness of the sorted banknotes. Alternatively, the banknote handling device may determine the authenticity of banknotes whose authenticity has been determined at a different site. When the banknote handling device is a device for handling banknotes BN sorted as genuine notes, an authenticity determiner 25b may be omitted.

[0087] As described above, in the above embodiment, the device (method) includes the first image collection unit 15a that collects reflection image data of a banknote BN under transport on the transport path 12 (first image collection step), the second image collection unit 15b that collects transmission image data of the banknote BN under transport on the transport path 12 (second image collection step), and the banknote detector 22 that detects at least one of the external shape or the presence or absence of the banknote BN based on the reflection image data and the transmission image data (banknote detection step). Thus, the transmission image data and the reflection image data are complementary to each other and the device and the method can detect at least one of the external shape or the presence or absence of a banknote BN based on the complementary data. This

can improve the precision of detecting at least one of the external shape or the presence or absence of a banknote BN having a transparent portion T.

[0088] In the above embodiment, the device and the method can highly precisely detect a banknote BN regardless of the presence or absence of a transparent portion T. Thus, the device and the method can be applied to banknotes BN of a variety of countries, and the technique of the above embodiment can be expanded as a standard specification to many countries.

[0089] In the above embodiment, the device and the method can highly precisely detect the shape of a banknote BN having a transparent portion T. Thus, the device can highly precisely calculate the size of a banknote BN such as the length of a banknote and the parameters relating to the state of the banknote BN under transport such as the skewing angle. This can reduce a decrease in passage of banknotes BN due to rejection and can reduce the chance of miscalculation due to misrecognition.

[0090] In the above embodiment, the first image collection unit 15a and the second image collection unit 15b share the light-receiving sensor 15Ac or the light source 15Aa. The former can lead to better cost efficiency than the latter, while the latter can lead to better precision of detecting the external shape of a banknote BN than the former.

[0091] In the above embodiment, the banknote detector 22 binarizes the reflection image data and the transmission image data to generate binarized reflection image data and binarized transmission image data, executes OR processing on the binarized reflection image data and the binarized transmission image data to generate the OR-processed image data, and detects at least one of the external shape or the presence or absence of a banknote BN based on the OR-processed image data. This enables more secure detection of at least one of the external shape or the presence or absence of a banknote BN.

[0092] In the above embodiment, the banknote detector 22 detects at least one of the external shape or the presence or absence of a banknote BN based on the data of each line of the reflection image data and the data of each line of the transmission image data corresponding to the data of each line of the reflection image data. This can shorten the detection time, and thus can shorten the recognition processing time.

INDUSTRIAL APPLICABILITY

[0093] As described above, the present invention provides a technique useful for detecting the external shape and/or the presence or absence of a sheet.

REFERENCE SIGNS LIST

[0094]

1a: light transmissive region
 1b, 2b, 3b, 4c: medium region
 1c, 2c: background region
 2a: light reflective region
 2d, 4d: ink region
 3a: medium-present region
 10: sensor unit
 11: transport mechanism
 12: transport path
 13a, 13b: photo sensor
 15: image sensor module
 15A: upper unit
 15B: lower unit
 15a: first image collection unit
 15b: second image collection unit
 15Aa, 15Ba: light source
 15Ab, 15Bb: condenser
 15Ac, 15Bc: light-receiving sensor
 15Ad, 15Bd: transparent plate
 15Ae, 15Be: substrate
 17: thickness detection sensor
 19: magnetic sensor module
 20: controller
 21: sensor information acquirer
 22: banknote detector
 22a: binarization processor
 22b: OR processor
 22c: edge extractor
 23: recognizer
 30: memory
 31: determination data
 31A: template
 31B: threshold
 100: banknote recognition device (sheet recognition device)
 101: banknote detection device (sheet detection device)
 200: banknote handling device
 210: hopper
 211: transport path
 213: stacker
 214: rejecter
 300: banknote handling device
 301: hopper
 302: rejecter
 303: operation unit
 305: display
 306a to 306d: stacker
 310: housing
 BN, BN1: banknote (sheet)
 T, T1: transparent portion
 W: width of transport path

Claims

1. A sheet detection device comprising:

a first image sensor configured to acquire reflection image data of a sheet under transport on a transport path;
 a second image sensor configured to acquire transmission image data of the sheet under transport on the transport path; and a controller configured to detect the presence or absence of the sheet based on the reflection image data and the transmission image data,
 wherein the controller is further configured:

to binarize the reflection image data and the transmission image data to generate binarized reflection image data and binarized transmission image data, respectively;
 to execute OR processing on the binarized reflection image data and the binarized transmission image data to generate OR-processed image data;
 to detect the external shape of the sheet based on the OR-processed image data; and
 to output outline information of an OR-processed image derived from the OR-processed image data.

2. The sheet detection device according to claim 1, wherein the first image sensor and the second image sensor share a light-receiving sensor.

3. The sheet detection device according to claim 1, wherein the first image sensor and the second image sensor share a light source.

4. The sheet detection device according to any one of claims 1 to 3, wherein the controller is configured:

to generate a 2D reflection image and a 2D transmission image from the reflection image data and the transmission image data, respectively; and
 to detect at least one of the external shape or the presence or absence of the sheet based on the 2D reflection image and the 2D transmission image.

5. The sheet detection device according to any one of claims 1 to 4, wherein the controller is configured to detect at least one of the external shape or the presence or absence of the sheet based on data of each line of the reflection image data and data of each line of the transmission image data corresponding to the data of each line of the reflection image data.

6. The sheet detection device according to any one of claims 1 to 5, wherein the first image sensor and the second image

sensor are configured to apply light of multiple wavelengths including infrared light to the sheet.

7. The sheet detection device according to any one of claims 1 to 6,
wherein the sheet has a base material that is a polymer or a composite of paper and a polymer. 5
8. The sheet detection device according to any one of claims 1 to 7,
wherein the controller is configured:
to detect the at least one of the external shape or the presence or absence of the sheet by comparing the reflection image data and the transmission image data; 15
to compare pixel values of pixels of the transmission image data with a first predetermined threshold, and to determine each pixel with a pixel value that is lower than the first predetermined threshold as medium-present, and each pixel with a pixel value that is not lower than the first predetermined threshold as medium-absent; and 20
to compare pixel values of pixels of the reflection image data with a second predetermined threshold, and to determine each pixel with a pixel value that is not lower than the second predetermined threshold as medium-present, and each pixel with a pixel value that is lower than the second predetermined threshold as medium-absent. 25
9. A sheet handling device comprising the sheet detection device according to any one of claims 1 to 8. 35
10. A sheet detection method comprising:
a first step of collecting reflection image data of a sheet under transport on a transport path; 40
a second step of collecting transmission image data of the sheet under transport on the transport path; and
a third step of detecting the presence or absence of the sheet based on the reflection image data and the transmission image data, 45
wherein the third step includes:
binarizing the reflection image data and the transmission image data to generate binarized reflection image data and binarized transmission image data, respectively; 50
executing OR processing on the binarized reflection image data and the binarized transmission image data to generate OR-processed image data; 55
detecting the external shape of the sheet based on the OR-processed image data;

and
outputting outline information of an OR-processed image derived from the OR-processed image data.

Patentansprüche

1. Bogennachweisvorrichtung mit:

einem ersten Bildsensor, der konfiguriert ist, um Reflexionsbilddaten eines Bogens während des Transports auf einem Transportweg zu erfassen;
einem zweiten Bildsensor, der so konfiguriert ist, dass er Transmissionsbilddaten des auf dem Transportweg transportierten Bogens erfasst; und
einer Steuerung, die dazu konfiguriert ist, basierend auf den Reflexionsbilddaten und den Transmissionsbilddaten das Vorhandensein oder Fehlen des Bogens zu erkennen, wobei die Steuerung ferner konfiguriert ist:

um die Reflexionsbilddaten und die Transmissionsbilddaten zu binarisieren, um binarisierte Reflexionsbilddaten bzw. binarisierte Transmissionsbilddaten zu erzeugen;
um eine ODER-Verarbeitung an den binarisierten Reflexionsbilddaten und den binarisierten Transmissionsbilddaten auszuführen, um ODER-verarbeitete Bilddaten zu erzeugen;
um die äußere Form des Bogens basierend auf den ODER-verarbeiteten Bilddaten zu erkennen; und
um Umrissinformationen eines ODER-verarbeiteten Bildes auszugeben, das aus den ODER-verarbeiteten Bilddaten abgeleitet ist.

2. Bogennachweisvorrichtung nach Anspruch 1, wobei sich der erste Bildsensor und der zweite Bildsensor einen Lichtempfangssensor teilen.

3. Bogennachweisvorrichtung nach Anspruch 1, wobei sich der erste Bildsensor und der zweite Bildsensor eine Lichtquelle teilen.

4. Bogennachweisvorrichtung nach einem der Ansprüche 1 bis 3, wobei die Steuerung konfiguriert ist:

um ein 2D-Reflexionsbild und ein 2D-Transmissionsbild aus den Reflexionsbilddaten bzw. den Transmissionsbilddaten zu erzeugen; und
um die äußere Form und/oder das Vorhandensein oder Fehlen des Bogens basierend auf

dem 2D-Reflexionsbild und dem 2D-Transmissionsbild zu erfassen.

5. Bogennachweisvorrichtung nach einem der Ansprüche 1 bis 4, wobei die Steuerung konfiguriert ist, um die äußere Form und/oder das Vorhandensein oder Fehlen des Bogens basierend auf Daten jeder Zeile der Reflexionsbilddaten und Daten jeder Zeile der Transmissionsbilddaten, entsprechend den Daten jeder Zeile der Reflexionsbilddaten, zu erkennen. 5 10
6. Bogennachweisvorrichtung nach einem der Ansprüche 1 bis 5, wobei der erste Bildsensor und der zweite Bildsensor konfiguriert sind, um Licht mehrerer Wellenlängen einschließlich Infrarotlicht auf den Bogen aufzubringen. 15
7. Bogennachweisvorrichtung nach einem der Ansprüche 1 bis 6, wobei der Bogen ein Basismaterial aufweist, das ein Polymer oder ein Verbund aus Papier und einem Polymer ist. 20 25
8. Bogennachweisvorrichtung nach einem der Ansprüche 1 bis 7, wobei die Steuerung konfiguriert ist:

um die äußere Form oder das Vorhandensein oder Fehlen des Bogens durch Vergleichen der Reflexionsbilddaten und der Transmissionsbilddaten zu erfassen; Pixelwerte von Pixeln der Transmissionsbilddaten mit einem ersten vorbestimmten Schwellenwert zu vergleichen und jeden Pixel mit einem Pixelwert, der niedriger als der erste vorbestimmte Schwellenwert ist, als Medium-vorhanden zu bestimmen, und jeden Pixel mit einem Pixelwert, der nicht niedriger ist als der erste vorbestimmte Schwellenwert als Medium-fehlend; und Pixelwerte von Pixeln der Reflexionsbilddaten mit einem zweiten vorbestimmten Schwellenwert zu vergleichen und jeder Pixel mit einem Pixelwert, der nicht niedriger als der zweite vorbestimmte Schwellenwert ist, als Medium-vorhanden zu bestimmen, und jeder Pixel mit einem Pixelwert, der niedriger ist als der zweite vorbestimmte Schwellenwert als Medium-fehlend. 30 35 40 45 50

9. Bogenhandhabungsvorrichtung mit der Bogennachweisvorrichtung nach einem der Ansprüche 1 bis 8.
10. Bogennachweisverfahren mit: 55

einem ersten Schritt des Sammelns von Reflexionsbilddaten eines auf einem Transportweg

transportierten Bogens;
einen zweiten Schritt des Sammelns von Transmissionsbilddaten des auf dem Transportweg transportierten Bogens; und
einen dritten Schritt des Erfassens des Vorhandenseins oder Fehlens des Bogens basierend auf den Reflexionsbilddaten und den Transmissionsbilddaten,
wobei der dritte Schritt umfasst:

Binarisieren der Reflexionsbilddaten und der Transmissionsbilddaten, um binarisierte Reflexionsbilddaten bzw. binarisierte Transmissionsbilddaten zu erzeugen;
Ausführen einer ODER-Verarbeitung an den binarisierten Reflexionsbilddaten und den binarisierten Transmissionsbilddaten, um ODER-verarbeitete Bilddaten zu erzeugen;
Erfassen der äußeren Form des Bogens basierend auf den ODER-verarbeiteten Bilddaten; und
Ausgeben von Umrissinformationen eines ODER-verarbeiteten Bildes, abgeleitet von den ODER-verarbeiteten Bilddaten.

Revendications

1. Dispositif de détection de feuille, comprenant :

un premier capteur d'image configuré pour acquérir des données d'image de réflexion d'une feuille transportée sur un chemin de transport ;
un second capteur d'image configuré pour acquérir des données d'image de transmission de la feuille transportée sur le chemin de transport ;
et
une unité de commande configurée pour détecter la présence ou absence de la feuille sur la base des données d'image de réflexion et des données d'image de transmission, dans lequel l'unité de commande est en outre configurée
pour binariser les données d'image de réflexion et les données d'image de transmission pour générer des données d'image de réflexion binarisées et des données d'image de transmission binarisées, respectivement ;
pour exécuter un traitement OU sur les données d'image de réflexion binarisées et les données d'image de transmission binarisées pour générer des données d'image ayant fait l'objet d'un traitement OU ;
pour détecter la forme externe de la feuille sur la base des données d'image ayant fait l'objet d'un traitement OU ; et
pour sortir des informations de contour d'une

- image, ayant fait l'objet d'un traitement OU, extraite des données d'image ayant fait l'objet d'un traitement OU.
2. Dispositif de détection de feuille selon la revendication 1,
dans lequel le premier capteur d'image et le second capteur d'image partagent un capteur de réception de lumière. 5
 3. Dispositif de détection de feuille selon la revendication 1,
dans lequel le premier capteur d'image et le second capteur d'image partagent une source de lumière. 10
 4. Dispositif de détection de feuille selon l'une quelconque des revendications 1 à 3,
dans lequel l'unité de commande est configurée : 15

pour générer une image de réflexion 2D et une image de transmission 2D à partir des données d'image de réflexion et des données d'image de transmission, respectivement ; et 20

pour détecter au moins une de la forme externe ou de la présence ou absence de la feuille sur la base de l'image de réflexion 2D et de l'image de transmission 2D. 25
 5. Dispositif de détection de feuille selon l'une quelconque des revendications 1 à 4,
dans lequel l'unité de commande est configurée pour détecter au moins une de la forme externe ou de la présence ou absence de la feuille sur la base de données de chaque ligne des données d'image de réflexion et de données de chaque ligne des données d'image de transmission correspondant aux données de chaque ligne des données d'image de réflexion. 30
 6. Dispositif de détection de feuille selon l'une quelconque des revendications 1 à 5,
dans lequel le premier capteur d'image et le second capteur d'image sont configurés pour appliquer de la lumière de multiples longueurs d'onde, y compris de la lumière infrarouge, sur la feuille. 35 40 45
 7. Dispositif de détection de feuille selon l'une quelconque des revendications 1 à 6,
dans lequel la feuille a un matériau de base qui est un polymère ou un composite de papier et d'un polymère. 50
 8. Dispositif de détection de feuille selon l'une quelconque des revendications 1 à 7, dans lequel l'unité de commande est configurée : 55

pour détecter l'au moins une de la forme externe ou de la présence ou absence de la feuille en

comparant les données d'image de réflexion et les données d'image de transmission ;
pour comparer des valeurs de pixel de pixels des données d'image de transmission à un premier seuil prédéterminé, et pour déterminer que chaque pixel avec une valeur de pixel qui est inférieure au premier seuil prédéterminé révèle la présence d'un support, et chaque pixel avec une valeur de pixel qui n'est pas inférieure au premier seuil prédéterminé révèle l'absence de support ; et
pour comparer des valeurs de pixel de pixels des données d'image de réflexion à un second seuil prédéterminé, et pour déterminer que chaque pixel avec une valeur de pixel qui n'est pas inférieure au second seuil prédéterminé révèle la présence de support, et chaque pixel avec une valeur de pixel qui est inférieure au second seuil prédéterminé révèle l'absence de support.

9. Dispositif de manipulation de feuille, comprenant le dispositif de détection de feuille selon l'une quelconque des revendications 1 à 8.

10. Procédé de détection de feuille, comprenant :

une première étape, de la collecte de données d'image de réflexion d'une feuille transportée sur un chemin de transport ;
une deuxième étape, de la collecte de données d'image de transmission de la feuille transportée sur le chemin de transport ; et
une troisième étape, de la détection de la présence ou absence de la feuille sur la base des données d'image de réflexion et des données d'image de transmission,
dans lequel la troisième étape inclut :

la binarisation des données d'image de réflexion et des données d'image de transmission pour générer des données d'image de réflexion binarisées et des données d'image de transmission binarisées, respectivement ;
l'exécution d'un traitement OU sur les données d'image de réflexion binarisées et les données d'image de transmission binarisées pour générer des données d'image ayant fait l'objet d'un traitement OU ;
la détection de la forme externe de la feuille sur la base des données d'image ayant fait l'objet d'un traitement OU ; et
la sortie d'informations de contour d'une image, ayant fait l'objet d'un traitement OU, extraite des données d'image ayant fait l'objet d'un traitement OU.

FIG.1

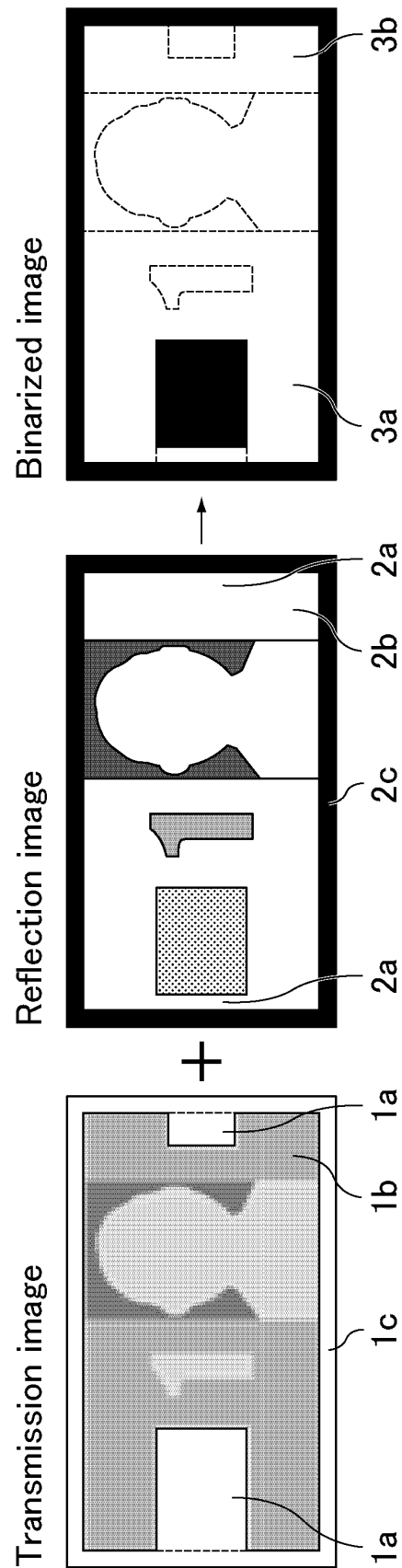


FIG. 2

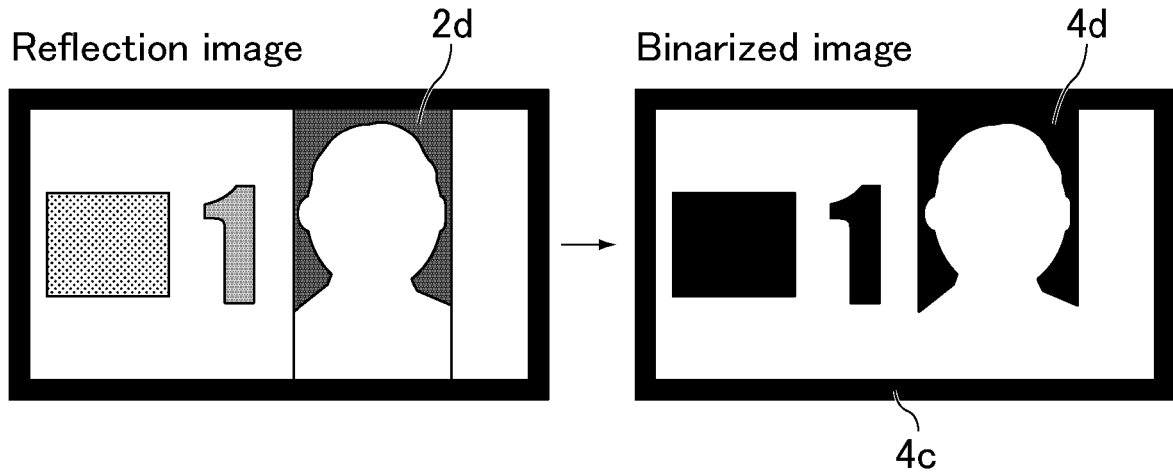


FIG. 3

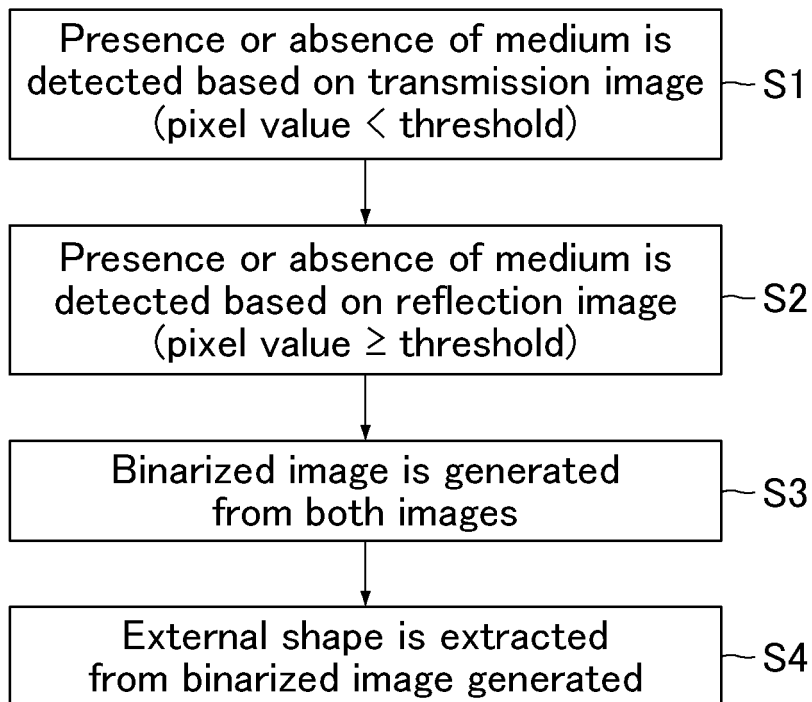
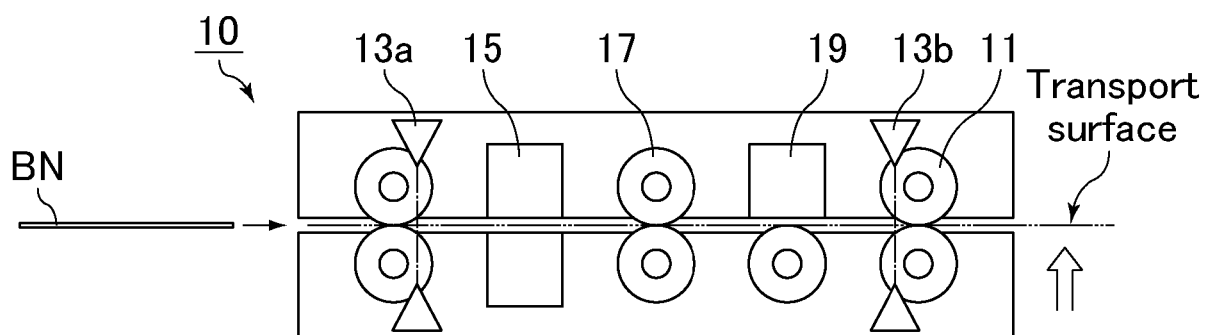


FIG.4

(a)



(b)

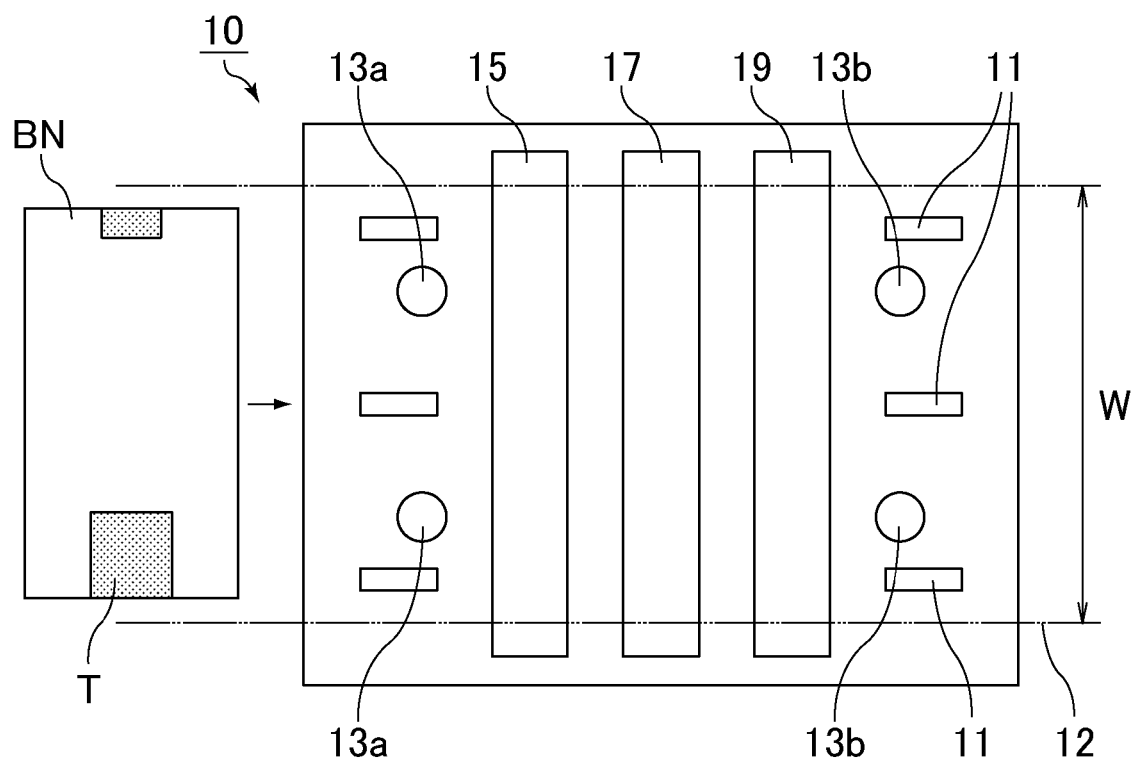


FIG. 5

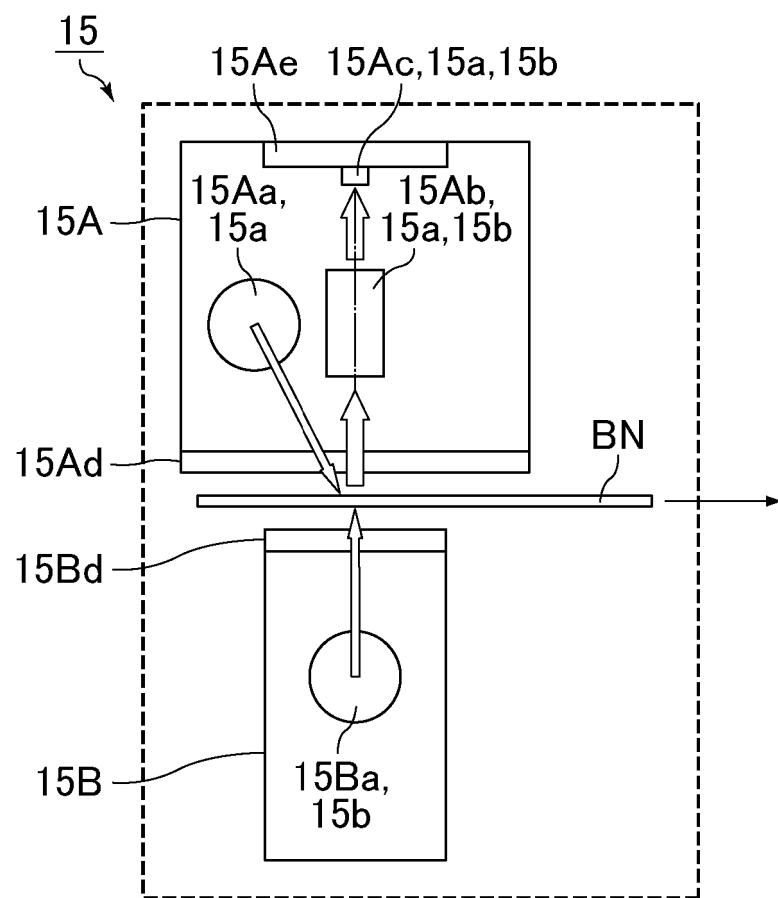


FIG. 6

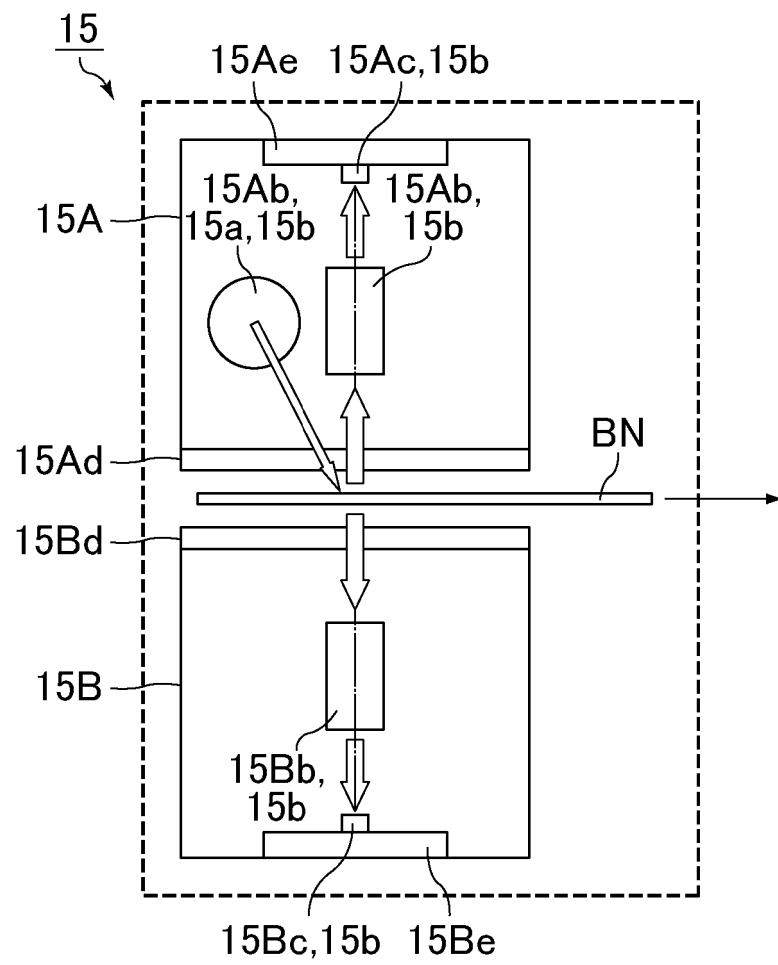


FIG. 7

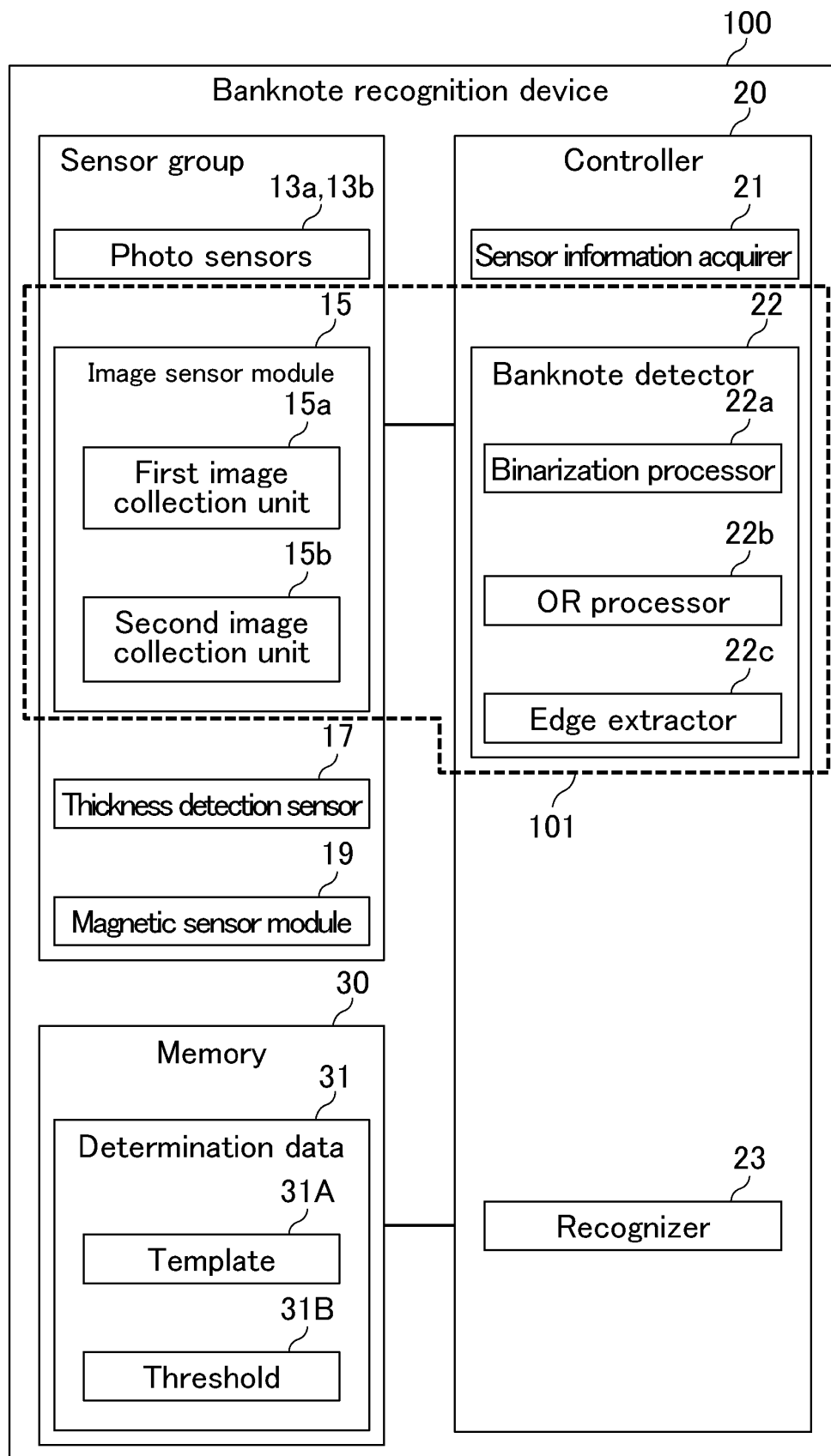


FIG.8

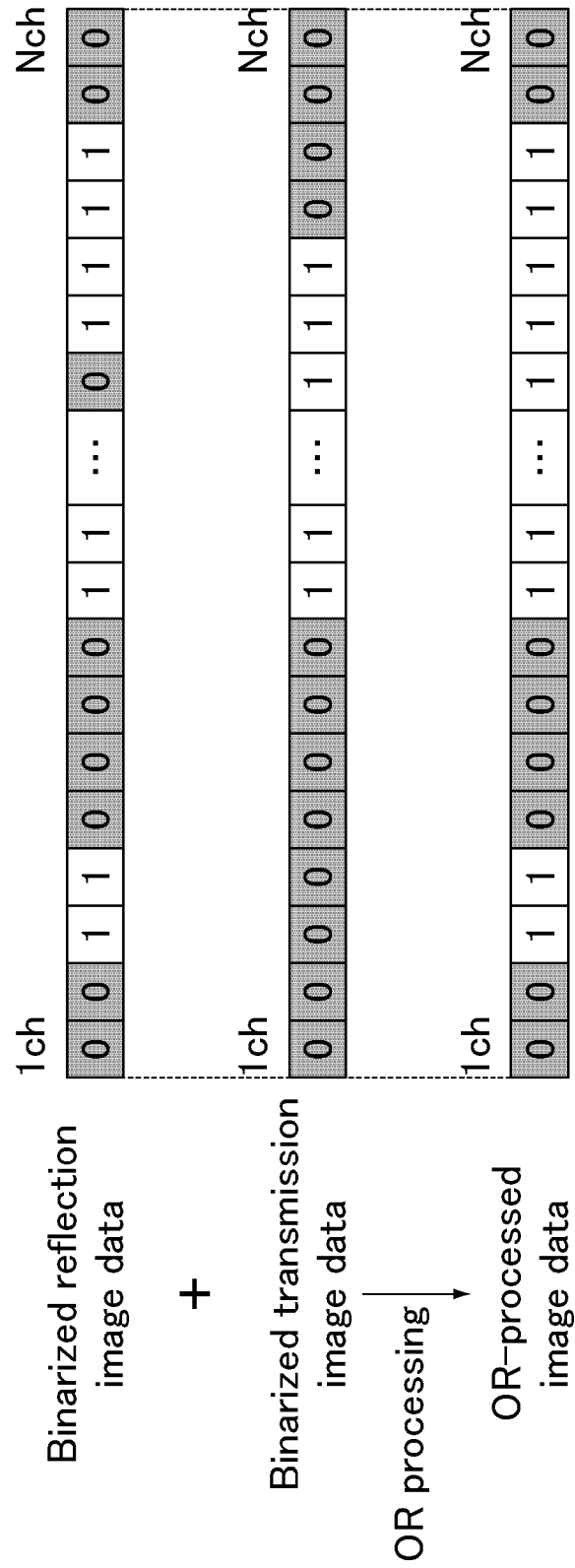


FIG.9

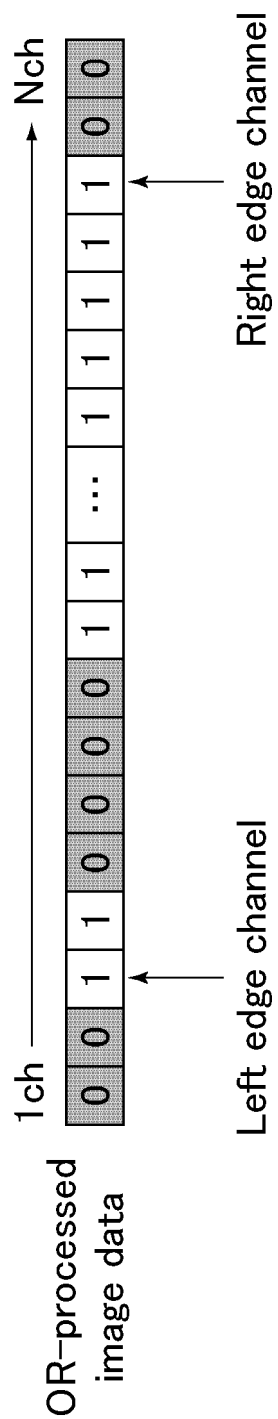


FIG.10

OR-processed
image data

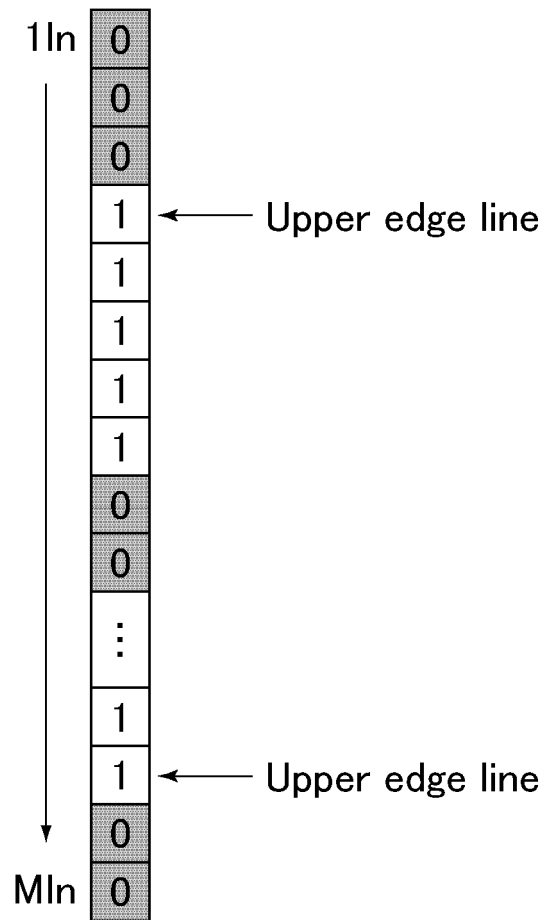
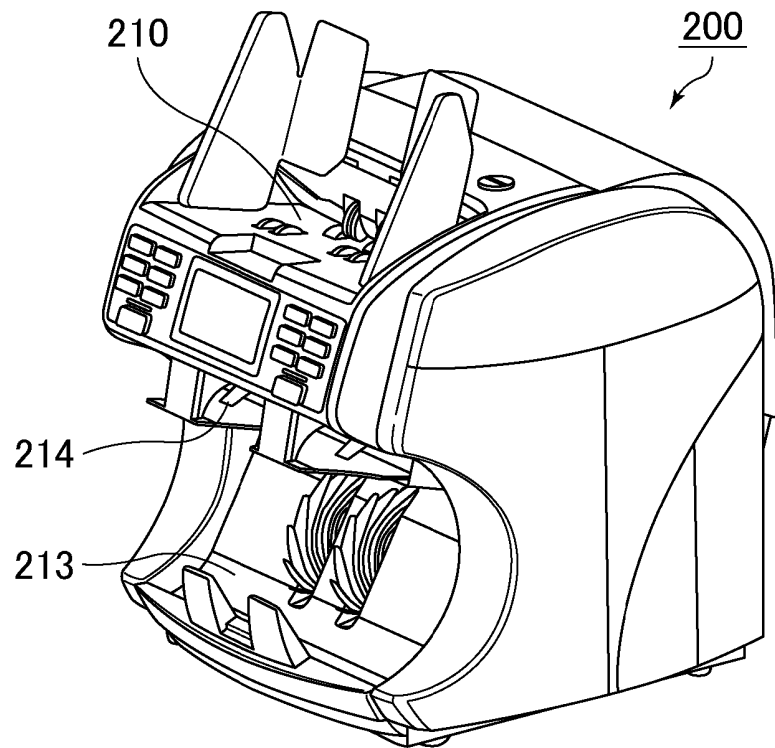


FIG. 11

(a)



(b)

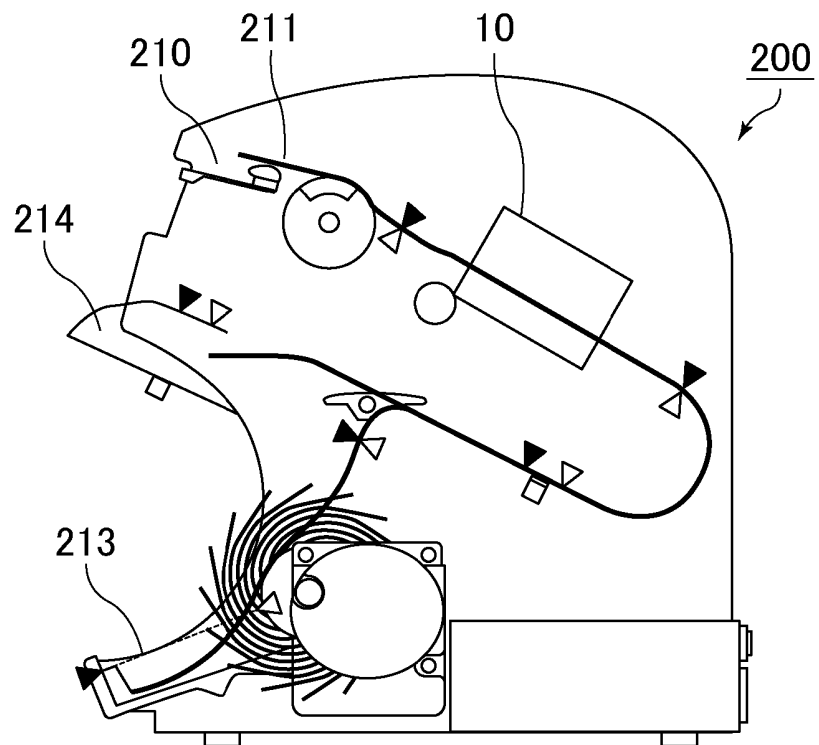


FIG.12

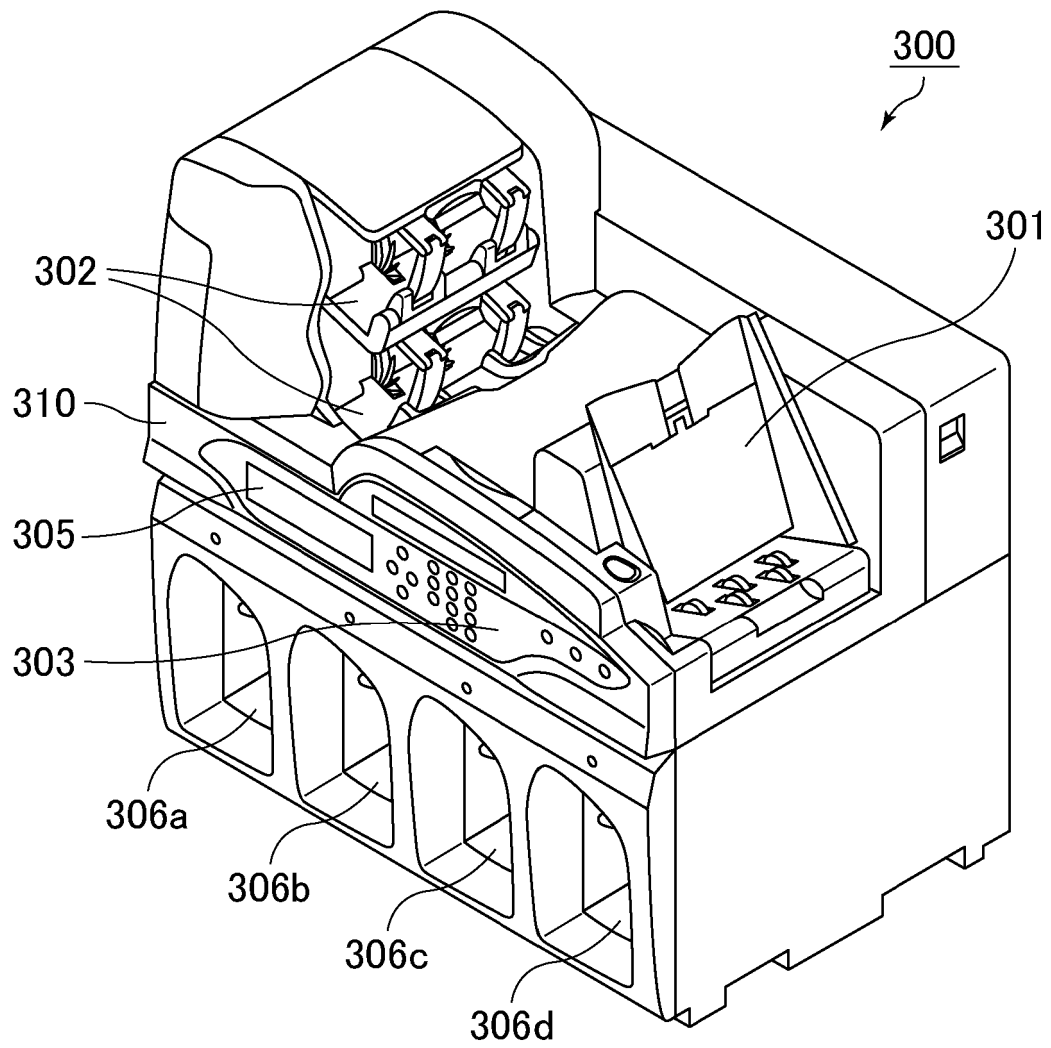


FIG.13

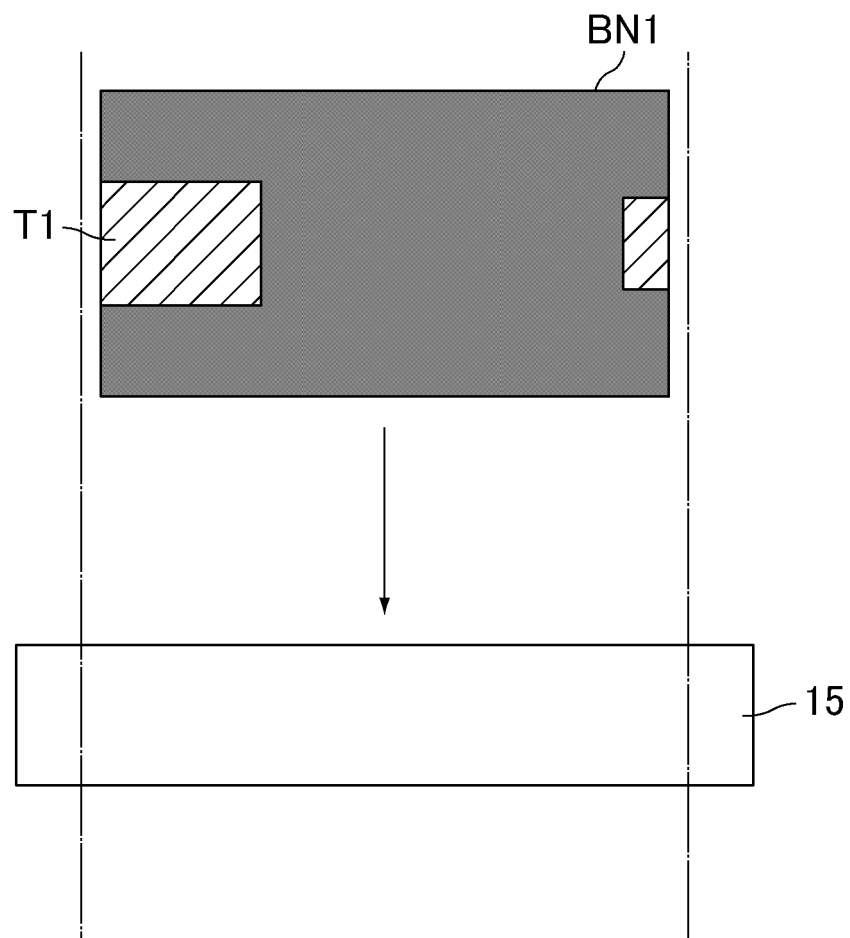
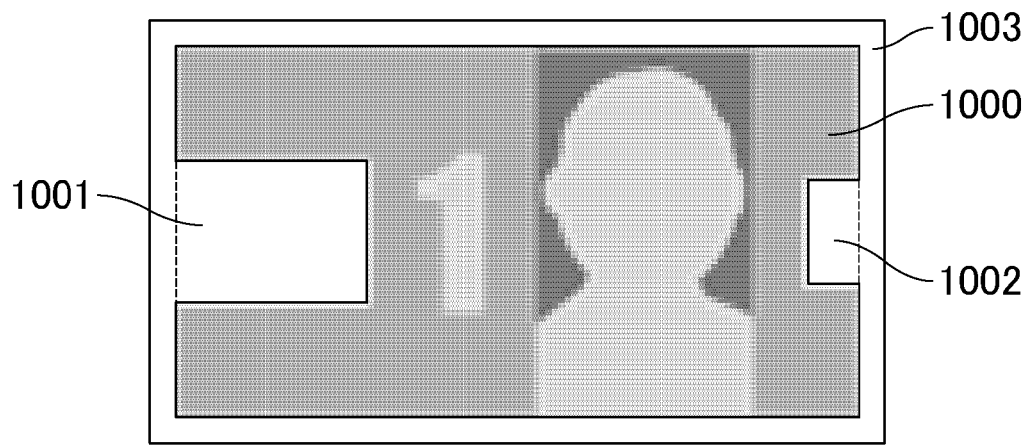
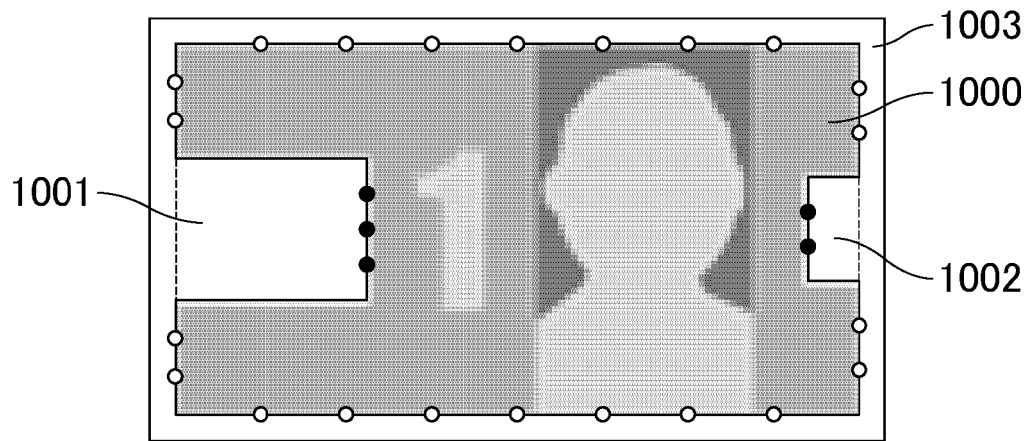


FIG. 14

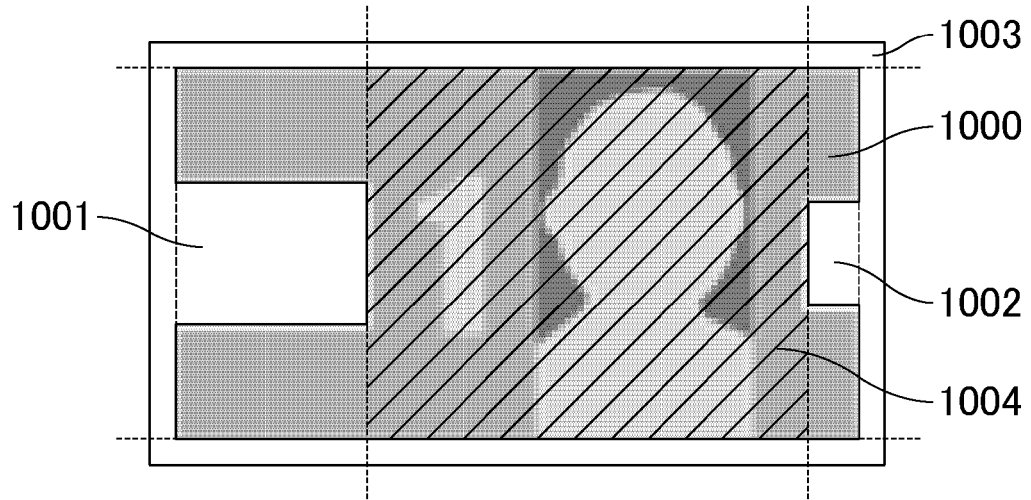
(a)



(b)



(c)



REFERENCES CITED IN THE DESCRIPTION

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