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### STORAGE MEDIUM STORING COLOR CONVERSION PROGRAM, COLOR CONVERSION APPARATUS, AND COLOR CONVERSION METHOD

#### Abstract

A non-transitory computer-readable storage medium storing a color conversion program causing a computer to execute a method including a first conversion step of converting a color space of image data by sequentially using an input profile and a print profile, and a second conversion step of converting the color space of the image data after the conversion in the first conversion step by sequentially using the print profile and a display profile. The input profile has first color information and receives image data. The print profile has second color information and outputs image data as print data when printing the image data by a printing apparatus. The display profile has third color information and outputs the image data as display data in displaying the image data on a display unit.

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## Background/Summary

### BACKGROUND

#### Field of the Disclosure

[0001] The present disclosure relates to a storage medium storing a color conversion program, a color conversion apparatus, and a color conversion method.

#### Description of the Related Art

[0002] In a printing apparatus, such as an MFP (Multi-Function Peripheral), printed matter is obtained by printing on a print sheet (medium) such as plain paper. Further, soft proof is known in which a simulation image of a printed matter is displayed on a color monitor and confirmed before obtaining the printed matter. A user can confirm finished colors in an actual printed matter by referring to the simulation image. In the printed matter that is actually printed, a part where images and characters are printed and a part where nothing is printed are greatly affected by a ground color of the print sheet. Therefore, it is preferable that the simulation image in the soft proof is an image in which the ground color of the print sheet is considered. Japanese Patent Laid-Open Publication No. 2023-081020 discloses a technique that rewrites a profile (color conversion parameter) that a display device applies to color matching (color space conversion) so as to bring a color reproduced by image display by the display device closer to a color of a color patch reproduced by printing by a printing apparatus. In this rewriting, the color is visually designated one by one, and the result is reflected to the profile.

[0003] However, when the print sheet is changed from plain paper to recycled paper or high-quality paper, for example, the technique described in the above publication needs to obtain printed matter and to rewrite the profile by visually designating colors one by one, every time the print sheet is changed. As a result, there is a problem that it takes time and effort to perform the color matching.

### SUMMARY

[0004] Embodiments of the present disclosure provide a mechanism capable of accurately and quickly performing color space conversion.

[0005] According to an aspect of the present disclosure, a non-transitory computer-readable storage medium storing a color conversion program causing a computer to execute a method including a first conversion step of converting a color space of image data by sequentially using an input profile and a print profile, and a second conversion step of converting the color space of the image data after the conversion in the first conversion step by sequentially using the print profile and a display profile. The input profile has color information and receives image data. The print profile has color information and outputs image data as print data in printing the image data by a printing apparatus. The display profile has color information and outputs the image data as display data in displaying the image data on a display unit.

[0006] According to embodiments of the present disclosure, the color space conversion can be performed accurately and quickly.

[0007] Further features will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

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## Description

## BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a block diagram illustrating a hardware configuration of an image processing apparatus according to a first embodiment.

[0009] FIG. **2** is a block diagram illustrating a hardware configuration of a printing apparatus connected to the image processing apparatus illustrated in FIG. **1**.

[0010] FIG. **3** is a view illustrating a table of relationship between a medium type and a printer output profile.

[0011] FIG. **4** is a view illustrating a print image confirmation screen on which a print image to be printed by the printing apparatus can be confirmed.

[0012] FIG. **5** is a view illustrating a color conversion process of a comparative example of the embodiment.

[0013] FIG. **6** is view illustrating a color conversion process executed by the image processing apparatus.

[0014] FIG. **7** is a flowchart illustrating the color conversion process performed in the image processing apparatus to simulate a printed matter output from the printing apparatus.

[0015] FIG. **8** is a flowchart illustrating the color conversion process performed in an image processing apparatus in a second embodiment to simulate a printed matter output from the printing apparatus.

## DESCRIPTION OF THE EMBODIMENTS

[0016] Hereafter, some exemplary embodiments according to the present disclosure will be described in detail by referring to the drawings. However, configurations described in the following embodiments are merely examples, and the scope of the present disclosure is not limited by the configurations described in the embodiments. For example, each unit constituting the present disclosure can be replaced with any configuration capable of exhibiting the same function. In addition, an arbitrary constituent may be added. In addition, two or more arbitrary configurations (features) of the embodiments may be combined.

[0017] A first embodiment will now be described with reference to FIGS. **1** to **7**. FIG. **1** is a block diagram illustrating a hardware configuration of an image processing apparatus related to the first embodiment. The image processing apparatus **100** illustrated in FIG. **1** is configured by an information processing apparatus, such as a desktop or notebook personal computer, a tablet terminal, or a smartphone. The image processing apparatus **100** is not limited to the information processing apparatus, and may be a device such as a DFE (Digital Front End) that performs a data process for inputting data to a printing apparatus.

[0018] As shown in FIG. **1**, the image processing apparatus **100** has a CPU **101**, a ROM **102**, a RAM **103**, a storage unit **104**, an operation unit **105**, and a display unit (display device) **106**, which are communicatively connected to each other via a system bus **107**. The image processing apparatus **100** is a color conversion apparatus capable of performing a color conversion process (a color conversion method) to convert a color space using an input profile **603**, a printer output profile (print profile) **604**, and a monitor profile (display profile) **607**.

[0019] The input profile **603** has color information and to which image data is input. The printer output profile **604** has color information and can output image data as print data when the image data is printed by the printing apparatus **200**. The monitor profile **607** has color information, and can output image data as display data when a display unit **106** displays the image data. The input profile **603**, the printer output profile **604**, and the monitor profile **607** are used to improve color reproducibilities of the printing apparatus **200** and the display unit **106**. The color information that the input profile **603**, the printer output profile **604**, and the monitor profile **607** have will be described later.

[0020] The CPU **101** is a controller (computer) that controls the entire image processing apparatus **100**. The ROM **102** is a read-only memory and stores application programs and parameters that do

not require change. The RAM **103** is a volatile random access memory and is used as a work area of the CPU **101** and a temporary storage area of various data.

[0021] The storage unit **104** is, for example, an HDD or an SSD, and

[0022] stores spools of various data, programs, information files, image data, etc., and is used as a work area. The CPU **101** develops an operating system, the application programs, etc. in the ROM **102** and the storage unit **104** to the RAM **103** and executes them. The application programs are stored in the ROM **102** and the storage unit **104** as program codes readable by the CPU **101**. The application programs include, for example, a color conversion program for converting a color space of image data.

[0023] The CPU **101** also functions as a means for reading an image file from the storage unit **104** and obtaining image data from the image file. The CPU **101** also functions as an image processor that executes various image processes on image data. Specifically, the CPU **101** functions as a color conversion unit that executes the color conversion program to perform color conversion process on image data.

[0024] The CPU **101** also functions as a means for recognizing the printing apparatus **200** (see FIG. 2) connected to the image processing apparatus **100**. The printing apparatus **200** is, for example, a printer to be used for printing. The CPU **101** also functions as a means for receiving, from the connected printing apparatus **200**, media information about the printing apparatus **200**, printer-output profile information associated with the media information, and a printer-output profile used for the color conversion process.

[0025] The CPU **101** also functions as a means for specifying the printer-output profile corresponding to the printing apparatus **200** on the basis of the media information obtained from the printing apparatus **200**, the printer-output profile information associated with the media information, and the printer-output profile.

[0026] The CPU **101** obtains the printer output profile corresponding to the printing apparatus **200** from the printing apparatus **200**. The CPU **101** also functions as a means for displaying an image on the display unit **106** by developing the image data read from the storage unit **104** to a display memory (not illustrated).

[0027] The CPU **101** also functions as a generator that generates data used for printing. The operation unit **105** includes, for example, a keyboard, a mouse, or the like, and can accept an operation by a user to the image processing apparatus **100**. The display unit **106** is, for example, a liquid crystal display or a CRT display, and can display the data held in the image processing apparatus **100**, the data during the image process, and the data from the outside of the image processing apparatus **100**.

[0028] FIG. 2 is a block diagram illustrating a hardware configuration of the printing apparatus connected to the image processing apparatus illustrated in FIG. 1. As shown in FIG. 2, the printing apparatus **200** includes a CPU **201**, a ROM **202**, a RAM **203**, a storage unit **204**, an operation unit **205**, and a printing unit **206**, which are communicably connected to each other via a system bus **207**. The printing apparatus **200** and the image processing apparatus **100** may be connected to each other by wire or wirelessly. The printing apparatus **200** and the image processing apparatus **100** may be connected via a local area network.

[0029] The CPU **201** is a computer (controller) that controls the entire printing apparatus **200**. The ROM **202** is a read-only memory and stores application programs and parameters that do not require change. The RAM **203** is a volatile random access memory and is used as a work area of the CPU **201** and a temporary storage area of various data. The storage unit **204** is, for example, an HDD or an SSD, and stores spools of various data, programs, information files, image data, etc., and is used as a work area. The CPU **201** develops the operating system and the application programs stored in the ROM **202** and the storage unit **204** to the RAM **203** and executes them.

[0030] The application programs are stored in the ROM **202** and the storage unit **204** as program codes readable by the CPU **201**, for example. The CPU **201** extracts the printer output profile

stored in the storage unit **204** in association with the medium by using the medium information selected through the operation unit **205**. The CPU **201** also functions as a color conversion means that performs the color conversion process in combination with the input profile and rendering intent selected through the operation unit **205**.

[0031] The CPU **201** also functions as a means that causes the printing unit **206** to print an image. The operation unit **205** includes, for example, operation buttons, a touch panel, a keyboard, a mouse, or the like, and can accept an operation by the user to the printing apparatus **200**. The printing unit **206** prints the data transmitted from the image processing apparatus **100**, the data held by the printing apparatus **200**, and the like.

[0032] FIG. **3** is a view illustrating a table of relationship between a medium type and a printer output profile. In this embodiment, the printing apparatus **200** is configured so that a plurality of types of print sheets (media), such as plain paper, glossy paper, and recycled paper, can be mounted. The plain paper is a print sheet that is the most versatile among plain paper, glossy paper, and recycled paper, and is also called “PPC paper”. The glossy paper is a print sheet having a glossy surface, and is suitable for photo printing. The recycled paper is a print sheet containing recycled paper pulp, and is, for example, more brownish or grayish than plain paper. In the printing apparatus **200**, when desired image data is printed, one type of print sheet can be selected from among a plurality of types of print sheets.

[0033] In a media profile list **300** illustrated in FIG. **3**, the printer output profile **604** is provided for each type of print sheet used for printing in the printing apparatus **200**, that is, for each medium type. For example, when an image is printed on the recycled paper, the image is subjected to the color conversion using a profile **302**, which is a “profile 5” corresponding to the recycled paper **301** in the media profile list **300**, and then the image is printed. The media profile list **300** is stored in the storage unit **204** of the printing apparatus **200**. When a desired medium is added to the media profile list **300**, a printer output profile corresponding to the medium is generated and added.

[0034] FIG. **4** is a view illustrating a print image confirmation screen on which a print image to be printed by the printing apparatus can be confirmed. The print image confirmation screen **400** illustrated in FIG. **4** includes a medium type selection list **401a**, a monitor profile list **401b**, a check item list **401c**, an original image display area **402**, and a preview image display area **403**. In the medium type selection list **401a**, all the media types (paper brands) registered in the media profile list **300** are displayed in a pop-up manner, and one medium type can be selected from among all the media types. In the display example illustrated in FIG. **4**, the “recycled paper” is selected in the medium type selection list **401a**. In this case, the profile **302**, which is the “profile 5”, is used for the color conversion process as the printer output profile **604**.

[0035] In the monitor profile list **401b**, all the monitor profiles usable in the color conversion process are displayed in a pop-up manner, and one monitor profile **607** can be selected from among all the monitor profiles. In the display example illustrated in FIG. **4**, “monitor calibration 20230911” is selected in the monitor profile list **401b**.

[0036] In the check item list **401c**, all items that can be checked for a preview image displayed in the preview image display area **403** are displayed in a pop-up manner, and one item can be selected from among all the items. In the display example illustrated in FIG. **4**, a “print color” is selected in the check item list **401c**.

[0037] In the original image display area **402**, a preview image of the print data before the color conversion is displayed. In the preview image display area **403**, a preview image of the print data after the color conversion is displayed. For example, when the “recycled paper” is selected in the medium type selection list **401a** and the “print color” is selected in the check item list **401c**, a preview image of a printed matter that would be obtained by printing the print data after the color conversion on the recycled paper is displayed.

[0038] As described above, the recycled paper has a brown or grayish ground color. Therefore, when the image is printed on the recycled paper, the ground color of the recycled paper affects the

printing result (printed matter). In the display example illustrated in FIG. 4, the preview image of the preview image display area **403** reproduces the print color affected by the ground color of the recycled paper.

[0039] FIG. 5 is a view illustrating a color conversion process of a comparative example of the embodiment. The color conversion process **500** illustrated in FIG. 5 is executed by a printing apparatus **200**, and a color conversion process **510** is executed by an image processing apparatus. First, the color conversion process **500** will be described.

[0040] As shown in FIG. 5, the color conversion process **500** uses an input profile **502** and a printer output profile **503** in sequence. Print data (image data) **501** is input to the input profile **502**. The print data **501** includes, for example, an image IM1 illustrated in FIG. 5. The input profile is a file for converting an image expressed in an RGB color space or a CMYK color space into an image expressed in an L\*a\*b\* color space. That is, the input profile is a lookup table in which values of colors expressed in the RGB format or the CMYK format are respectively associated with values of colors expressed in the L\*a\*b\* format in a one-to-one manner.

[0041] The L\*a\*b\* color space is a device independent (model independent) color space that does not depend on the model of the printing apparatus **200** and is standardized by International Illumination Committee (CIE), for example. Instead of the L\*a\*b\* color space, an XYZ color space may be used. On the other hand, the RGB color space and the CMYK color space are device dependent (model dependent) color spaces that are individually set for each model according to the model of the printing apparatus **200**.

[0042] In the input profile **502** to which the print data **501** is input, the image expressed in the RGB color space or the CMYK color space of the print data **501** is converted into the image expressed in the L\*a\*b\* color space. The data including the L\*a\*b\* color space obtained by the input profile **502** is input to the printer output profile **503**.

[0043] The printer output profile is a file for converting an image expressed in the L\*a\*b\* color space to an image expressed in the CMYK color space. In the printer output profile **503**, the image expressed in the L\*a\*b\* color space is converted into an image expressed in the CMYK color space. When the print sheet used for printing is the recycled paper, the above described "profile 5" is selected as the printer output profile **503**. Then, the printing apparatus **200** outputs a printed matter Q that the image IM2 is printed on the recycled paper as the printer output **505** from the printing unit **206**. The printed matter Q reflects the ground color of the recycled paper.

[0044] When data in the L\*a\*b\* color space exceeding the color gamut reproducible by the printing apparatus **200** is input to the printer output profile **503**, it is preferable to perform gamut mapping for mapping colors so that the colors fall within the color gamut the printing apparatus **200**. The printer output profile **503** has a plurality of (normally three) color conversion tables to which the gamut mapping method is applied. One of these color conversion tables is selected according to a designation by a rendering intent **504**.

[0045] The rendering intent designates (sets) relative chromaticity retention in order to reproduce the colors of the image IM1 itself included in the print data **501** as much as possible. Then, the printer output profile **503** applies the color conversion process that subtracts (cancels) a ground color component of the recycled paper by the designation of the color conversion table by the rendering intent **504**. This enables printing on the recycled paper with the color of the image IM1 itself reproduced as much as possible.

[0046] In addition, for example, when a printing apparatus of which a color tone is influenced by temperature or humidity is used as the printing apparatus **200**, it is preferable to perform calibration so to always output a printed matter with the same color tone. The calibration is preferably performed for each print sheet. The calibration result is preferably fed back to the printer output profile **503**. This further improves the color reproducibility.

[0047] Further, although the relative chromaticity retention is selected by the rendering intent **504** in this embodiment, this is not limiting. For example, it is also possible to designate that priority is

given to smoothness of gradation at the time of printing over color reproduction, or priority is given to a more vivid print result.

[0048] Next, the color conversion process **510** will be described. As shown in FIG. 5, in the color conversion process **510**, an input profile **512** and a monitor profile **513** are used in sequence. The print data **501** is input to the input profile **512**. A profile similar to the input profile **502** is designated as the input profile **512**.

[0049] In the input profile **512** to which the print data **501** is input, the image of the print data **501** expressed in the RGB color space or the CMYK color space is converted into the image expressed in the  $L^*a^*b^*$  color space. The monitor profile **513** receives data including the  $L^*a^*b^*$  color space obtained by the input profile **512**.

[0050] The monitor profile is a file to convert an image expressed in the  $L^*a^*b^*$  color space to an image represented in the RGB color space. In the monitor profile **513**, the image expressed in the  $L^*a^*b^*$  color space is converted into the image expressed in the RGB color space. Then, an image **IM3** is displayed as a monitor display **515** on the display unit **106** in the image processing apparatus **100**. The image **IM3** is different from the printed matter **Q** and the ground color of the recycled paper is not reflected to the image **IM3**. Therefore, the color tone of the image **IM3** cannot be visually recognized to be identical to that of the printed matter **Q** (image **IM2**). And it is not preferable to use the image **IM3** as the preview image of the printed matter **Q**.

[0051] When the data in the  $L^*a^*b^*$  color space exceeding the color gamut reproducible by the image processing apparatus **100** is input to the monitor profile **513**, it is preferable to perform gamut mapping for mapping colors so that the colors fall within the color gamut of the image processing apparatus **100**. The monitor profile **513** has a plurality of color conversion tables to which the gamut mapping method is applied. One of these color conversion tables is selected by the designation of the rendering intent **514**.

[0052] FIG. 6 is a view illustrating the color conversion process executed by the image processing apparatus. As illustrated in FIG. 6, the image processing apparatus **100** sequentially and continuously executes a color conversion process (first conversion step) **600** and a color conversion process (second conversion step) **601**. First, the color conversion process **600** will be described. In the color conversion process **600**, the input profile **603** and the printer output profile **604** are used in sequence. The input profile **603** and the printer output profile **604** function as a first conversion unit that converts the color space in the color conversion process **600**.

[0053] The print data **602** is input to the input profile **603**. A profile similar to the input profile **502** is designated as the input profile **603**. And data similar to the print data **501** is used as the print data **602**. Therefore, the print data **602** includes the image **IM1**.

[0054] In the input profile **603** to which the print data **602** is input, the image expressed in the RGB color space or the CMYK color space of the print data **602** is converted into the image expressed in the  $L^*a^*b^*$  color space. The data including the  $L^*a^*b^*$  color space obtained by the input profile **603** is input to the printer output profile **604**. As the printer output profile **604**, the same one as the printer output profile **503**, that is, the above-described “profile 5” is designated.

[0055] Then, in the printer output profile **604**, the image expressed in the  $L^*a^*b^*$  color space is converted to the image expressed in the CMYK color space. In the process in the printer output profile **604**, one color conversion table is selected according to designation by a rendering intent **605** similar to the rendering intent **504**. Such a color conversion process **600** generates the data having the CMYK color space that falls within the color gamut of the printing apparatus **200**.

[0056] Next, the color conversion process **601** executed after the color conversion process **600** will be described. In the color conversion process **601**, a printer output profile **606** and the monitor profile **607** are used in sequence. The printer output profile **606** and the monitor profile **607** function as a second conversion unit that converts the color space in the color conversion process **601**. The data having the CMYK color space that falls within the color gamut of the printing apparatus **200**, which is generated by the color conversion process **600** using the printer output

profile **606** as an input profile, is input to the printer output profile **606**.

[0057] A profile similar to the printer output profile **604** is designated as the printer output profile **606**. In the printer output profile **606**, an image expressed in the CMYK color space is converted into an image expressed in the L\*a\*b\* color space.

[0058] Note that in general, a profile has two functions. The first function converts an image expressed in the RGB color space or the CMYK color space, that is, an image expressed in the device dependent color space, into an image expressed in the L\*a\*b\* color space, that is, an image expressed in the device independent color space. The second function converts an image expressed in the L\*a\*b\* color space into an image expressed in the RGB color space or the CMYK color space, which is opposite to the first function.

[0059] The printer output profile **604** is performing the second function, while the printer output profile **606** is performing the first function. Whether the first function or the second function is performed is switched depending on what color space the input data has.

[0060] The data including the L\*a\*b\* color space obtained by the printer output profile **606** is input to the monitor profile **607**. In the monitor profile **607**, the image expressed in the L\*a\*b\* color space is converted into the image expressed in the RGB color space. Then, an image IM4 is displayed as a monitor display (display image) **609** on the display unit **106** in image processing apparatus **100**.

[0061] In the process in the monitor profile **607**, one color conversion table is selected according to designation by a rendering intent **608** similar to the rendering intent **514**. The rendering intent **608** designates absolute chromaticity retention. As a result, the image IM4 reflects the ground color of the recycled paper as with the printed matter Q, that is, does not cancel the ground color component of the recycled paper.

[0062] Therefore, the color tone of the image IM4 can be visually recognized to be identical to that of the printed matter Q (image IM2) obtained when the data converted in the first conversion step is printed by the printing apparatus **200**. Thus, it is preferable to use the image IM4 as the preview image of the printed matter Q.

[0063] In this way, since the image processing apparatus **100** sequentially and continuously executes the color conversion process **600** and the color conversion process **601**, it is possible to accurately and quickly perform the conversion of the color space suitable for the preview image. In this case, a media white point included in the monitor profile **607** is used as one color conversion table selected according to the designation by the rendering intent **608**.

[0064] When a color of a patch printed on a print sheet is measured, a measurement value of a part without colorant, i.e., a measurement value of a white display on the display unit **106**, is used as the media white point. That is, the measurement value of the white display on the display unit **106** is used as the media white point also for the monitor profile **607** having the measurement value obtained by measuring the ground color of the print sheet.

[0065] Then, the user of these media white points enables to perform the color conversion process in which the ground color is taken into consideration. The print data **602** subjected to the color conversion process in this way can be displayed on the display unit **106** in a state in which the ground color of the print sheet (recycled paper) is reproduced with high accuracy. Alternatively, the ground color may be reproduced by using a white point of the color conversion table, that is, a color of a grid point of (C, M, Y, K)=(0, 0, 0, 0) as-is.

[0066] In addition, when the display unit **106** is a color monitor, a deviation may occur in a display color due to aging deterioration or the like. In this case, it is preferable to perform calibration for correcting the deviation of the display color. The calibration result is preferably fed back to the monitor profile **607**. This further improves the color reproducibility of the display unit **106**.

[0067] FIG. 7 is a flowchart illustrating the color conversion process performed in the image processing apparatus to simulate a printed matter output from the printing apparatus. The process in each step in the flowchart shown in FIG. 7 is achieved by the CPU **101** reading the program stored



in the ROM **102** or the storage unit **104** to the RAM **103** and executing the program.

[0068] As shown in FIG. 7, in a step **S701**, the CPU **101** of the image processing apparatus **100** obtains print data (image data of a print target) to be printed by the printing apparatus **200**, which is stored in the storage unit **104**, and proceeds with the process to a step **S702**.

[0069] In the step **S702**, the CPU **101** obtains the input profile used during printing from the storage unit **204** of the printing apparatus **200** and proceeds with the process to a step **S703**.

[0070] In the step **S703**, the CPU **101** displays the print image confirmation screen **400** on the operation unit **105** of the image processing apparatus **100** and obtains the medium type selected (designated) in the medium type selection list **401a** in the print image confirmation screen **400**. Then, the process proceeds to a step **S704**.

[0071] In the step **S704**, the CPU **101** obtains the printer output profile corresponding to the medium type obtained in the step **S703** from the media profile list **300** stored in advance in the storage unit **204** of the printing apparatus **200**, and proceeds with the process to a step **S705**.

[0072] In the step **S705**, the CPU **101** obtains the rendering intent specified on the operation unit **205** of the printing apparatus **200**, and proceeds with the process to a step **S706**.

[0073] In the step **S706**, the CPU **101** designates the input profile **603** obtained in the step **S702** as the input profile. Further, the CPU **101** designates the printer output profile **604** obtained in the step **S704** as the printer output profile.

[0074] Also, the CPU **101** designates the rendering intent **605** obtained in the step **S705** as the rendering intent for the printer output profile **604**. Then, the CPU **101** executes the color conversion process **600** described above, and proceeds with the process to a step **S707**.

[0075] In the step **S707**, the CPU **101** obtains the monitor profile corresponding to the display unit **106**, which is stored in storage unit **104**, and proceeds with the process to a step **S708**.

[0076] In the step **S708**, the CPU **101** designates the printer output profile **604** obtained in the step **S704** as the printer output profile that will be the input profile of the color conversion process **601**. Further, the CPU **101** designates the monitor profile **607** obtained in the step **S707** as the monitor profile to be the output profile in the color conversion process **601**. Further, the CPU **101** designates the rendering intent **605** as the rendering intent for the printer output profile **604**. Then, the CPU **101** executes the color conversion process **601** described above and proceeds with the process to a step **S709**.

[0077] In the step **S709**, the CPU **101** stores the print target image data obtained in the color conversion process in the step **S708** in the storage unit **104** and ends the process.

[0078] Hereinafter, a second embodiment will be described with reference to FIG. 8. The description will focus on differences from the above-described embodiment, and the descriptions about the same matters will be omitted. This embodiment is the same as the first embodiment except that a rasterizing step of applying a rasterizing process to the image data is executed between the first conversion step and the second conversion step.

[0079] FIG. 8 is a flowchart illustrating the color conversion process performed in an image processing apparatus in a second embodiment to simulate a printed matter output from the printing apparatus. As shown in FIG. 8, in a step **S801**, the CPU **101** obtains the print data to be printed by the printing apparatus **200**, which is stored in the storage unit **104**, and proceeds with the process to a step **S802**. The print data is data described in a page description language, and includes, for example, a character string, a line or a figure by a vector, and an image such as a photograph.

[0080] In the step **S802**, the CPU **101** obtains the input profile to be used during printing from the storage unit **204** of the printing apparatus **200**, and proceeds with the process to a step **S803**.

[0081] In the step **S803**, the CPU **101** displays the print image confirmation screen **400** on the operation unit **105** of the image processing apparatus **100** and obtains the medium type selected in the medium type selection list **401a** in the print image confirmation screen **700**. And then, the process proceeds to a step **S804**.

[0082] In the step **S804**, the CPU **101** obtains the printer output profile corresponding to the

medium type obtained in the step S803 from the media profile list 300 stored in advance in the storage unit 204 of the printing apparatus 200, and proceeds with the process to a step S805.

[0083] In the step S805, the CPU 101 obtains the rendering intent designated on the operation unit 205 of the printing apparatus 200, and proceeds with the process to a step S806.

[0084] In the step S806, the CPU 101 designates the input profile 603 obtained in the step S802 as the input profile. Further, the CPU 101 designates the printer output profile 604 obtained in the step S804 as the printer output profile. Further, the CPU 101 designates the rendering intent 605 obtained in the step S805 as the rendering intent for the printer output profile 604. Then, the CPU 101 executes the color conversion process 600 described above and proceeds with the process to a step S807.

[0085] In the step S807, the CPU 101 applies a RIP process (rasterizing process) to the data obtained in the color conversion process in the step S806 to generate a raster image (a rasterizing step). After the execution in the step S807, the process proceeds to a step S808.

[0086] In the step S808, the CPU 101 obtains the monitor profile corresponding to the display unit 106, which is stored in the storage unit 104, and proceeds with the process to a step S809.

[0087] In the step S809, the CPU 101 designates the printer output profile 604 obtained in the step S804 as the printer output profile 606 in the color conversion process 601. Further, the CPU 101 designates the monitor profile 607 obtained in the step S808 as the monitor profile in the color conversion process 601, and designates the rendering intent 608 as the rendering intent for the monitor profile 607. Then, the CPU 101 executes the color conversion process 601 described above and proceeds with the process to a step S810. The target of the color conversion process in the step S809 is the raster image generated in the step S807.

[0088] In the step S810, the CPU 101 stores the print object image obtained by the color conversion process in the step S809 in the storage unit 104 and ends the process. As described above, in this embodiment, the RIP process is executed in the step S807 before the color conversion process in the step S809. Accordingly, the image of the background part which is not included in the print data is complemented, and the color conversion process can be performed in the step S809 even for the complemented part. Therefore, the preview image of the printed matter in which the ground color of the print sheet is considered can be reproduced on the display unit 106 with high accuracy.

#### Other Embodiments

[0089] Embodiment(s) of the present disclosure can also be realized by a computer of a system or apparatus that reads out and executes computer executable instructions (e.g., one or more programs) recorded on a storage medium (which may also be referred to more fully as a 'non-transitory computer-readable storage medium') to perform the functions of one or more of the above-described embodiment(s) and/or that includes one or more circuits (e.g., application specific integrated circuit (ASIC)) for performing the functions of one or more of the above-described embodiment(s), and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the computer executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s) and/or controlling the one or more circuits to perform the functions of one or more of the above-described embodiment(s). The computer may comprise one or more processors (e.g., central processing unit (CPU), micro processing unit (MPU)) and may include a network of separate computers or separate processors to read out and execute the computer executable instructions. The computer executable instructions may be provided to the computer, for example, from a network or the storage medium. The storage medium may include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD) TM), a flash memory device, a memory card, and the like.

[0090] While various embodiments of the present disclosure have 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. [0091] This application claims the benefit of Japanese Patent Application No. 2024-023524, filed Feb. 20, 2024, which is hereby incorporated by reference herein in its entirety.

## Claims

1. A non-transitory computer-readable storage medium storing a color conversion program causing a computer to execute a method comprising: a first conversion step of converting a color space of image data by sequentially using an input profile that has first color information and receives image data, and a print profile that has second color information and outputs image data as print data when printing the image data by a printing apparatus; and a second conversion step of converting the color space of the image data after the conversion in the first conversion step by sequentially using the print profile, and a display profile that has third color information and outputs the image data as display data in displaying the image data on a display unit.
2. The non-transitory computer-readable storage medium according to claim 1, wherein the print profile is used when a rendering intent is set in the first conversion step.
3. The non-transitory computer-readable storage medium according to claim 2, wherein the rendering intent designates relative chromaticity retention.
4. The non-transitory computer-readable storage medium according to claim 3, wherein the first conversion step further includes performing a conversion that cancels a ground color component of a print sheet used when printing by the printing apparatus is performed by using the print profile in a state where the rendering intent is set.
5. The non-transitory computer-readable storage medium according to claim 1, wherein the display profile is used in a state where a rendering intent is set in the second conversion step.
6. The non-transitory computer-readable storage medium according to claim 5, wherein the rendering intent designates absolute chromaticity retention.
7. The non-transitory computer-readable storage medium according to claim 6, wherein the second conversion step includes performing conversion that does not cancel a ground color component of a print sheet used when printing by the printing apparatus by using the display profile in a state where the rendering intent is set.
8. The non-transitory computer-readable storage medium according to claim 1, wherein in the first conversion step, the color space of the image data input to the input profile is converted from a model dependent color space set for each model of the printing apparatus into a model independent color space that does not depend on the model of the printing apparatus, by using the input profile.
9. The non-transitory computer-readable storage medium according to claim 8, wherein in the first conversion step, the color space of the image data converted by the input profile is converted from the model independent color space into the model dependent color space by using the print profile.
10. The non-transitory computer-readable storage medium according to claim 9, wherein in the second conversion step, the color space of the image data converted in the first conversion step is converted from the model dependent color space to the model independent color space by using the print profile.
11. The non-transitory computer-readable storage medium according to claim 10, wherein in the second conversion step, the color space of the image data converted by the print profile is converted from the model independent color space to a color space reproducible by the display unit using the display profile.
12. The non-transitory computer-readable storage medium according to claim 1, wherein the print profile is provided for each type of print sheet used for printing by the printing apparatus.
13. The non-transitory computer-readable storage medium according to claim 12, wherein in the

first conversion step and the second conversion step, the print profile corresponding to the print sheet selected in the printing apparatus from among a plurality of types of print sheets mounted on the printing apparatus is used.

**14.** The non-transitory computer-readable storage medium according to claim 1, wherein the control method further comprises a rasterizing step of applying a rasterizing process to the image data between the first conversion step and the second conversion step.

**15.** The non-transitory computer-readable storage medium according to claim 1, wherein a color tone of the printed matter obtained by printing the image data converted in the first conversion step by the printing apparatus is visually recognized to be identical to a color tone of the display image obtained by displaying the image data converted in the second conversion step on the display unit.

**16.** A color conversion apparatus comprising: one or more memories storing an input profile that has first color information and receives image data, an input profile that has first color information and receives image data, a print profile that has second color information and outputs the image data as print data when printing the image data by a printing apparatus, and a display profile that has third color information and outputs the image data as display data in displaying the image data on a display unit; one or more control programs; and one or more processors configured to cause, by executing the one or more control programs, the color conversion apparatus to: convert a color space of the image data using the input profile and the print profile in sequence; and convert the color space of the image data by using the print profile and the display profile in sequence.

**17.** A color conversion method comprising: a first conversion step of converting a color space of image data by sequentially using an input profile that has first color information and receives image data, and a print profile that has second color information and outputs image data as print data when printing the image data by a printing apparatus; and a second conversion step of converting the color space of the image data after the conversion in the first conversion step by sequentially using the print profile, and a display profile that has third color information and outputs the image data as display data in displaying the image data on a display unit.

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