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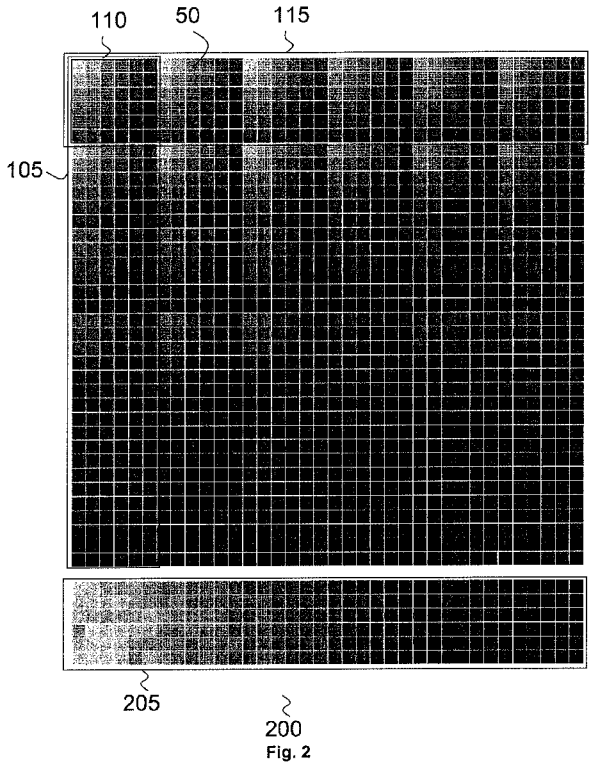


Fig. 2

(57) Abstract: The invention is a remodelling method which consists of printing and measuring a very limited number of color patches in a printing mode and reusing the printer model of an other printing mode, but correcting the color measurements ($m_{a,i}$) of the other printer model with the measured limited number of color patches ($m_{s,j}$) of the printer model.

Description

A printer remodelling method

Technical Field

[0001] The present invention relates to methods and systems for the reproduction of color documents such as printing of color documents. The invention especially concerns color management. The invention is particularly suitable for fast printer modelling method.

Background Art

[0002] Characterization of a multi-color printer is typically done by printing a large number of color patches on a printer target to make a dedicated printer model. In proofing this procedure is followed to make a dedicated printer model for each printing mode. The printing mode includes settings of the multi-color printer like the resolution, ink drop volumes, number of passes.

[0003] Often even a dedicated printer model is made per multi-color printer, to assure very accurate color reproduction. Typical printer targets contain between 1000 and 2000 color patches.

[0004] In contrast, linearization of a multi-color printer requires printing much less color patches and should be done on a regular basis, to keep the device in a steady condition.

[0005] The setup of a color characterization is much more tedious, but has to be done only once. This procedure is no longer feasible in inkjet printing, especially industrial inkjet printing. In inkjet printing, one multi-color inkjet printer is used to print on a variety of substrates, ranging from coated paper to plastics, plexi-glass, wood, metal. Doing the full works for each of these substrates and each of these multi-color inkjet printers is too time consuming and labour intensive.

[0006] As the quality requirements are less stringent than in proofing applications, what is often done is reusing printer models for different printing modes, assuming that the linearization, which consists in printing and measuring a limited number of patches of the primary colors, will make up for the inadequate printer model. Often even no calibration at all is performed. This will however give inaccurate color reproduction, most commonly resulting in bad output of neutral colors and incorrect dot gain behavior.

[0007] So there is need of a printer remodelling to produce more accurate colors across printing modes by following a method that is less time consuming than the color characterization with printer targets comprising a large amount of patches.

Summary of invention

[0008] In order to overcome the problems such as time consuming and intensive labour described above, preferred embodiments of the present invention have been realised with a printer remodelling method as defined by claim 1.

[0009] The method consists of printing and measuring a very limited number of color patches in a printing mode and reusing the printer model of an other printing mode, but correcting the color measurements ($m_{a,i}$) of the other printer model with the measured limited number of color patches ($m_{s,j}$) of the printer model .

[0010] The embodiment is a printer remodelling method of a first printer model (M_a) to a second printer model (M_b) for a multi-color printer with an N-dimensional colorant space; where N is more than one; and wherein the first printer model (M_a) determines a first print mode of the multi-color printer and the second printer model (M_b) determines a second print mode of the multi-color printer, comprising the following steps:

- determining the color measurements ($m_{a,i}$) of the first printer model (M_a) of the multi-color printer; and
- generating a printer target defined in the N-dimensional colorant space of the multi-color printer; and
- printing the target color measurement by the multi-color printer in the second print mode on a substrate; and
- measuring the printer target by a color measuring device as color measurements of the second print mode ($m_{s,j}$); and
- remapping the color measurements of the first printer model ($m_{a,i}$) to color measurements of the second printer model ($m_{b,i}$) by analyzing the color measurements of the second print mode ($m_{s,j}$); and
- generating the second printer model (M_b) from the color measurements of the second print mode ($m_{s,j}$); and

wherein the amount of patches be measured in the printer target is 90% less than the amount of color measurements of the first printer model (M_a).

[0011] Hence with 90% less measurements for the second printer model and the knowledge of a first printer model, a fast calculation of a second printer model (M_b) can be achieved. The print target is now a small printer target in stead of the large printer targets that is used in color characterization of a printer.

[0012] In a preferred embodiment the first printer model (M_a) is generated from color measurements from an extended colorant-combination print target. The extra patches with neutral and semi-neutral colors gives a higher color conversion accuracy of the first printer model (M_a) but it gives also a higher accuracy of the generation of the second printer model (M_b).

[0013] Preferably the amount of patches be measured in the printer target is 95% less than the amount of color measurements of the first printer model (M_a). In a preferred embodiment the printer remodelling method comprises the following step for the remapping:

- determining from each color in the color measurements of the second print mode ($m_{s,j}$) a displacement vector ($v_{s,j}$) of the second print mode; and
- interpolating between the displacement vectors ($v_{s,j}$) to displacement vectors from each color in the color measurements of the first printer model ($m_{a,i}$).

[0014] The displacement vector ($v_{s,j}$) gives the advantage of a better remapping of the color measurements of the first printer model ($m_{a,i}$) by interpolation between the displacement vectors ($v_{s,j}$).

[0015] Preferably the displacement vector (vs,j) is a vector between the color of the color measurement of the second print mode ($m_{s,j}$) and a color of the color measurements of the first printer model ($m_{a,i}$) with the same set of colorant values as the color measurement of the second print mode ($m_{s,j}$) to achieve a better remapping.

[0016] But if there is no same set of colorant values available in the color measurements of the first printer model ($m_{a,i}$), an interpolation of a set of color measurements of the first printer model ($m_{a,i}$) is used as end point of the vector.

[0017] It is found that interpolating between the displacement vectors ($v_{s,j}$) by radial base function (RBF) interpolation method gives the best remapping because the set of colorant values of the color measurements of the second print mode ($m_{s,j}$) are scattered in the colorant space of the printer.

[0018] In a preferred embodiment the small printer target comprises:

[0019] - a patch wherein the set of colorant values is located at the boundary of the N-dimensional colorant space of the multi-color printer; and wherein the set of colorant values comprises minimum 2 values in the range of]0, 100%]; and/or

[0020] - a patch wherein the set of colorant is located at the ink-limitation boundary from the first printer model (M_a); and/or

[0021] - a patch wherein the set of colorant values is the centre of the ink-limitation boundary from the first printer model (M_a); and/or

[0022] - a patch wherein only one colorant value of the set of colorant values has a value which is selected from the range]0, 100%[and/or

[0023] - a patch is a neutral color or a semi-neutral color;

[0024] In a preferred embodiment the following steps are comprised
- inverting the first printer model (M_a); and
- determining a semi-neutral color with a chroma in CIE 1976 L*a*b* smaller than 20; and
- converting the color by the inverted first printer model (M_a^{-1}) to a set of colorant values; and
- assigning a patch in the printer target with the set of colorant values.

[0025] A patch wherein only one colorant value of the set of colorant values has a value which is selected from the range]0, 100%[is an advantage when it is comprised in the small printer target because it gives the ability to have a better dotgain correction in the second printer model (M_b).

[0026] A patch with a semi-neutral color is an advantage when it is comprised in the small printer targer because it gives the ability to have a better neutral color correction in the second printer model (M_b)

[0027] Preferably prior the the assigning the set of colorant to a patch comprises the step of determining the closest set of colorant values from the color measurements ($m_{a,i}$) of the first printer model (M_a) opposite the set of

colorant values of the converted color; and than assigning a patch in the printer target with the closest set of colorant values. The distance between two sets of colorants is defined by the distance function in an N-dimensional space, such as here the N-dimensional colorant space.

Brief description of drawings

[0028] FIG.1 illustrates a colorant-combination printer target (100) for a CMYK printer. The printer target comprises a plurality of patches (50). The patches are ordered in 6x6 matrix patches (110) wherein colorant values of cyan (C) and magenta values (M) are combined with 6 sampling points along the different colorant axes. A row of 6x6 matrix patches (115) comprises an extra combination with yellow colorant values (Y). A column of 6x6 matrix patches (105) comprises an extra combination with black colorant values (K). The total amount of patches is 1295 ($=6^4$).

[0029] FIG. 2 illustrates an extended colorant-combination printer target (200) for a CMYK printer. The printer target comprises a plurality of patches (50). The patches are ordered in 6x6 matrix patches (110) wherein colorant values of cyan (C) and magenta values (M) are combined with 6 sampling points along the different colorant axes. A row of 6x6 matrix patches (115) comprises an extra combination with yellow colorant values (Y). A column of 6x6 matrix patches (105) comprises an extra combination with black colorant values (K). The colorant-combination printer target is extended with a plurality patches of semi-neutral colors 205.

Description of embodiments

[0030]

Colorant gamut

[0031] The colorant gamut is defined by all possible combinations of colorant values, ranging from zero to $colorant_{maximum}$ for multi-color printers wherein $colorant_{maximum}$ is the maximum colorant value is. The $colorant_{maximum}$ is preferably a power of 2 minus 1 (2^n-1), such as 255 ($=2^8$-1) or 65535 ($=2^{16}$-1) and more preferably 100%.

[0032] If there are no colorant limitations, the colorant gamut is an N-dimensional cube. However, in most cases a number of colorant combinations are not acceptable to be printed. Hence the colorant gamut is reduced by ink

limitations. Ink limitations can be any limitation on one colorant or on a combination of colorants, such as an ink limitation wherein the sum of the values of the colorant is lower than 300% in a CMYK colorant gamut or an ink limitation wherein the maximum value of colorant K is lower than 90% in a CMYK colorant gamut. Ink limitations can be any limitation on colorant combinations to be taken into account. In this document, only linear ink limitations are considered, but all aspects of linear ink limitation can be easily extended to any combination of linear and/or non-linear ink limitations. More information about ink limitation is disclosed at Colour Engineering: Achieving Device Independent Colour . 1st edition. Edited by PHIL GREEN, et al. Wiley, 2002. ISBN 0471486884. It is especially disclosed in chapter 12 Color gamut determination from Marc Mahy and in chapter 13 Colour gamut mapping from Jan Morovic.

[0033] The boundary of an N-dimensional colorant space from a printer defines the outer surface of the N-dimensional colorant space of the printer. For example if there is no ink limitation in the multi-color printer the N-dimensional colorant space is an N-dimensional cube. The boundary of an N-dimensional colorant space of a printer corresponds to the boundary of the color gamut of the printer. The color gamut defines the range of colors achievable in a print mode of a printer. The boundary of the color gamut is the surface determined by the color gamut's extremes.

[0034] Paper white, the set of colorant values, wherein all colorant values are zero, is a point on the boundary of the N-dimensional colorant space of a printer such as the primaries, wherein one colorant value is $colorant_{maximum}$, and the others are zero and secondaries, wherein two colorant values are $colorant_{maximum}$ and the others are zero. Due to inklimitation the colorant value of primaries and secondaries may be limited to a color value smaller than the $colorant_{maximum}$.

Color space

[0035] With color space is meant a space that represents a number of quantities of an object that characterize its color. In most practical situations, colors will be represented in a three-dimensional space such as the CIE XYZ, CIE LAB or CIECAM02. However, also other characteristics can be used

such as multi-spectral values, whether or not, based on filters that are not necessarily based on a linear transformation of the color matching functions.

[0036] The values represented in a color space are referred to as color values. Device independent spaces are typical such color spaces. More information about color spaces is disclosed at Digital Color Imaging Handbook. Edited by GAURAV SHARMA. United States of America: CRC PRESS. Especially in chapter 1.5.1 CIE standards and chapter 1.7 Uniform color spaces and color differences.

[0037] A color value represented by multi-spectral values is also called a color spectrum.

[0038] A color value with a chroma in CIE 1976 L*a*b* smaller than 10 is a neutral color and a color value with a chroma in CIE 1976 L*a*b* smaller than 20 is a semi-neutral color.

Color measuring device

[0039] A colour measuring device is a device to measure a color from a printed substrate, such as spectrophotmeters. More information about color measuring devices is disclosed at Digital Color Imaging Handbook. Edited by GAURAV SHARMA. United States of America: CRC PRESS. Especially in chapter 1.11.4 Color recording systems.

[0040] Color measuring devices, such as spectrophotometers, are used primarily for determining the color characteristics of multi-color printers.

Printer model

[0041] A printer model is a mathematical relation that expresses color values in function of colorant values for a multi-color printer. The variables for the colorants are denoted as $c^1,c^2,\ldots,c^N$ with N the dimension of the multi-color printer's colorant space.

[0042] For the sake of clarity N is larger than one, thus the amount of colorants in the multi-color printer is larger than one.

[0043] The mathematical relation is derived from a color characterization of a multi-color printer. More information about printer model is disclosed at Colour Engineering: Achieving Device Independent Colour . 1st edition. Edited by PHIL GREEN, et al. Wiley, 2002. ISBN 0471486884. It is

especially disclosed in chapter 12 Color gamut determination from Marc Mahy.

[0044] With inverting a printer model is meant that the corresponding printer model is inverted. Hence the inverted printer model is a mathematical relation that expresses set of colorant values in function of color values in a color space.

[0045] Based on the printer model, forward and inverse look-up-tables (LUT) preferably are constructed. These look-up-tables are also referred to as color tables. A forward look-up-table transforms colorant values to color values whereas the inverse look-up-table transforms color values to colorant values. Inverse look-up-tables are also called separation tables or color separation tables. The forward and inverse look-up-tables (LUT) may be stored in a color profile.

[0046] In a preferred embodiment a printer model is regularized. More information about regularization of printer models is disclosed at WO 2013/124369 (AGFA GRAPHICS NV) .

[0047] The printer model comprises color measurements ($m_{a,i}$) which are the basis for the mathematical relation. Preferably the color measurements ($m_{a,i}$) are the measurements of the color characterization of the multi-color printer but more preferably the color measurements are regularized measurements of the color characterization. A color measurements ($m_{a,i}$) of a printer model may be derived from interpolation of measurements of the color characterization, for example if the printer target is not complete. More information about complete and incomplete printer targets is disclosed at EP 1146726 A (AGFA GRAPHICS NV) .

[0048] A color measurement ($m_{a,i}$) comprises the color value and its corresponding set of colorant values.

Color characterization

[0049] The color characterization derives the relationship between device-dependent and device indepent color representations for a multi-color printer, preferably a calibrated multi-color printer. The color characterization for multi-color printers preferably comprises the steps of measuring a printer target, such as IT8.7/3 CMYK target by a color

measuring device. More information is disclosed at ANSI IT8.7/3-2010 Graphic technology - Input data for characterization of 4-color process printing and is disclosed at Digital Color Imaging Handbook. Edited by GAURAV SHARMA. United States of America: CRC PRESS. Especially in chapter 5.3 Characterization targets and measurement techniques.

[0050] A printer target is also called profiling target and characterization target.

[0051] For the sake of clarity the printer target comprises patches with multiple combinations of the multi-color printer's colorants wherein the amount of the colorants in the multi-color printer is more than one. Typical profiling targets contain between 1000 and 2000 patches that have to be measured for the color characterization.

[0052] A printer target is normally characterized by the sampling points along the different colorant axes. Based on the sampling points a regular grid can be constructed in colorant space of which a number of grid points are contained by the printer target. Such a printer target is called a colorant-combination print target. For example if the amount of sampling points along the 4 colorant axes of a CMYK printer is 6, the amount of patches is 1296 ($=6^4$). Higher the amount of sampling points along the different colorant axes, higher the accuracy of the color characterization. The measurements of the color characterization may be stored in a color profile.

[0053] A color characterization depends on substrate characterization, rendering characterization and ink characterization. A print mode is a set of parameters that defines the print process such as substrate characterization, rendering characterization and ink characterization. A print mode may affect the quality of the print on a substrate.

[0054] A substrate characterization is the characterization of the printed susbtrate such as type of substrate, thickness of substrate, type of surface treatment of substrate.

[0055] A rendering characterization is the characterization how content is rendered and printed on the substrate such as type of halftoning, printing resolution, type of print masks in inkjet printers, number of passes in inkjet printers.

[0056] An ink characterization is the characterization of the used ink to print content on a substrate, such as type of inks, number of colorants, use of light and heavy inks, ink-drop volumes in inkjet printers.

Printer linearization

[0057] Preferably prior a color characterization of a multi-color printer, the multi-color printer is linearized. It is also called printer calibration. For the sake of clarity and to distinct from the color characterization, a printer linearization is based on color measurement of printed patches wherein only one colorant is printed. For example a printer linearization in a CMYK printer is performed after color measuring of 0%, 25%, 50%, 75% cyan (C) patches, 0%, 25%, 50%, 75% magenta (M) patches,0%, 25%, 50%, 75% yellow (Y) patches and 0%, 25%, 50%, 75% black (K) patches. The printed patches to generate the printer linearization are comprised in a linearization target.

[0058] A printer linearization is a one dimensional transformation for each colorant. Preferably the printer linearization is stored as look-up-table for each colorant in a color profile. The interpolation between the points in the look-up-table of a colorant is also called a linearization curve.

[0059] More information about printer linearization is disclosed at US US6575095 (AGFA GRAPHICS NV)

Color profiles

[0060] To make the transformations between colorant spaces and/or color space available to different applications that whish to use them, the printer model ma be stored in a color profile, also called a device profile. More information about color profiles is disclosed at Digital Color Imaging Handbook. Edited by GAURAV SHARMA. United States of America: CRC PRESS. Especially in chapter 1.12.1.3 Device profiles.

[0061] A color profile is preferably an ICC profile. An ICC profile is a set of data that characterizes a multi-color printer, according to standards promulgated by the International Color Consortium (ICC). ICC profiles describe the color attributes of a particular multi-color printer by defining a mapping between the device source or target color space and a profile connection space (PCS). This PCS is either CIELAB (L*a*b*) or CIEXYZ.

Mappings may be specified using tables, to which interpolation is applied, or through a series of parameters for transformations.

Color management systems

[0062] A color management system (CMS) is responsible for interpreting the printer models, preferably embedded in color profiles, and performing the appropriate transformations to and from the device independent color space. The goal of a CMS is to provide predictable and consistent color without requiring specialized skills from the user. More information about color management systems is disclosed at Digital Color Imaging Handbook. Edited by GAURAV SHARMA. United States of America: CRC PRESS. Especially in chapter 1.12.1 Color management systems. Preferably the embodiment is performed by a color management system.

[0063] Preferably the colour management system (CMS) is compatible with ICC profiles; and/or able to build custom colour profiles to match and to certify a multi-color printer to a proofing standard such as ISO 12647-2 or ISO 12647-7.

[0064] Information about color management systems, especially a color management system compatible with ICC profiles, is disclosed at Color Management: Understanding and Using ICC Profiles. Edited by PHIL GREEN. WILEY, 2010. ISBN 0470058250.

Multi-color printer

[0065] Today, more and more output systems are developed for the reproduction of content. Several printing technologies are used such as electrophotography, thermal transfer, dye sublimation and ink jet systems to name a few. A multi-color printer is a printer, such as a toner-based printer, an inkjet printer, wherein multiple colorants are used to reproduce content such as an image. For example a CMYK inkjet printer is a multi-color printer with 4 colorants: cyan (C), magenta (M), yellow (Y) and black (K) which jets ink on a substrate to reproduce content.

[0066] In a preferred embodiment the multi-color inkjet printer is an inkjet printer.

[0067] A multi-color printer may also using conventional printing systems such as offset printing, rotogravure, flexography, letterpress printing, and screen-

printing are developed for the reproduction of images and/or text with multiple colorants.

[0068] Offset printing, which is an example of a conventional printing system, is a printing technique in which ink is spread on a metal plate with etched images, then transferred (offset) to an intermediary rubber blanket and finally to the printing surface by pressing the paper to the blanket. When printing color images, four plates are normally used, one for each CMYK component. Additionally, spot colors can be added by adding a new layer with the specific pigment needed.

[0069] Nowadays modern offset systems use computer to plate technology, which create plates directly from the computer output, contrary to the older technology where photographic films were created by computers and then used for creating the plate. Offset presses are big, expensive and complex devices which require experienced operators to run them. The process of preparing a document to be printed in an offset press is complicated, since plates have to be created and the operators have to spend some time manually preparing and calibrating the offset press to get the desired result. Even though this process is rather expensive and slow, the actual printing process is cheap, fast and produces high image quality.

[0070] This makes it a good solution for producing large amounts of copies. For this reason, it has become the most popular way of commercial printing and it is largely used for printing newspapers, magazines, books, etc.

[0071] In an inkjet printer, which is an example of a digital printing system, the ink is directly deposited onto the paper, simplifying the printing mechanism and eliminating all the process of creating plates. Besides, it avoids the extra job that offset operators need to do in order to get the offset press ready for printing. Both things lead to a shorter turnaround time, cheaper starting point for a single copy and copies customization (which is not possible in offset since it is unviable to create a different plate for each copy).

[0072] Another advantage is the possibility of print a wider gamut (closer to the RGB gamut) than with offset. Also it is easier to print in almost every surface: wood, ceramic, plastic, etc. The quality of offset presses has

always been considered higher in terms of resolution and crispness than for digital presses such as inkjet systems, although nowadays there are digital presses such as inkjet systems matching up the quality of offset presses. Nevertheless, digital printing has some disadvantages with respect to offset which can make difficult the decision of choosing one or another printing method. The resolution of a digital press depends on the dots per inch (dpi) parameter. Even though this parameter has been gradually increasing over the years, the quality of a digital press cannot be compared yet to the quality of an offset press in terms of resolution and crispness. Another shortcoming of digital presses is the handling of spot colors. Typically a digital press uses CMYK pigments to represent all the colors. As mentioned, only a subset of spot colors can be properly represented using CMYK. Some complex digital presses use an additional fifth or sixth colorant which helps to the reproduction of a larger subset of spot colors but still not enough to reproduce all of them in a good way.

[0073] More information about printing technology is disclosed at HELMUT KIPPHAN. Handbook of Print Media: Technologies and Production Methods. Springer, 2001. ISBN 3540673261.

[0074] In a preferred embodiment a multi-color printer comprises minimum two of the following colorants: cyan (C), magenta (M), yellow (Y), black (K), orange (O), green (G), violet (V), red (R), green (G) and preferably comprises a spot color such as a Pantone color.

[0075] More information about Pantone colors can be found on the website of Pantone LLC, a wholly owned subsidiary of X-Rite, Incorporated (www.pantone.com).

Radial basis function

[0076] A radial basis functions (RBF) are means to approximate multivariable (also called multivariate) functions by linear combinations of terms based on a single univariate function (the radial basis function). This is radialised so that in can be used in more than one dimension. They are usually applied to approximate functions or data which are only known at a finite number of points so that then evaluations of the approximating function can take place often and efficiently.

[0077] The radial basis functions are found to be very effective in the remapping step of the embodiment

[0078] More information about radial basis functions (RBF) is disclosed at MARTIN D. BUHMANN. Radial Basis Functions. Press syndicate of the university of Cambridge. ISBN 0521633389.

[0079] Another source of radial basis functions (RBF) is disclosed at a thesis of Grady B. Wright "Radial Basis Function Interpolation: Numerical and Analytical Developments", submitted to the Faculty of the Graduate School of the University of Colorado for the degree of Doctor of Philosophy at the Department of Applied Mathematics in 2003.

Example

[0080] The method may start by choosing a multivariate radial symmetric function:

$$\varphi : R^3 \rightarrow R$$

in the case of interpolation in a three-dimensional color space.

$$\varphi(x) = \varphi(|x|)$$

where |x| is the Euclidean norm in R^3.

[0081] It is found that the following form of basis function have the best result:

$$\varphi(x) = \sqrt{|x|^2 + \lambda}$$

[0082] In a preferred embodiment wherein a radial basis functions is used the previous form of basis function is preferred.

[0083] The parameter λ is used to control the smoothness of the interpolation.

Extended colorant-combination print target

[0084] An extended colorant-combination print target is a colorant-combination print target comprising extra patches with semi-neutral colors and preferably neutral colors. It is found that the measurements of these extra patches give a higher accurate printer model of a printer. The regular grid gets around the luminance axis in the color space a higher resolution

which gives a better color conversion for neutral and semi-neutral colors when such printer model is used for color conversion.

[0085] To improve the accuracy of printer models more, a set of the extra patches may be assigned with a semi-neutral color wherein each patch of this set is assigned with a set of colorant values with different gray color removal setting (GCR) of the semi-neutral color. These patches are a great advantage in the inverting of the printer model wherein gray color removal setting is a parameter.

[0086] Another embodiment is the generation of an extended colorant-combination print target for a more accurate printer model. Preferably the generation of an extended colorant-combination print target is comprised in a color management system (CMS).

Reference signs list

[0087] 50 patch

100 colorant-combination printer target

105 a column of 6x6 matrix patches

110 6x6 matrix patches

115 a row of 6x6 matrix patches

200 extended colorant-combination printer target

205 a plurality of patches with semi-neutral colors

Claims

1. A printer remodelling method of a first printer model (M_a) to a second printer model (M_b) for a multi-color printer with an N-dimensional colorant space; where N is more than one; and
wherein the first printer model (M_a) determines a first print mode of the multi-color printer and the second printer model (M_b) determines a second print mode of the multi-color printer,
comprising the following steps:
- determining the color measurements ($m_{a,i}$) of the first printer model (M_a) of the multi-color printer; and
- generating a printer target defined in the N-dimensional colorant space of the multi-color printer; and
- printing the target color measurement by the multi-color printer in the second print mode on a substrate; and
- measuring the printer target by a color measuring device as color measurements of the second print mode ($m_{s,j}$); and
- remapping the color measurements of the first printer model ($m_{a,i}$) to color measurements of the second printer model ($m_{b,i}$) by analyzing the color measurements of the second print mode ($m_{s,j}$); and
- generating the second printer model (M_b) from the color measurements of the second print mode ($m_{s,j}$); and
wherein the amount of patches be measured in the printer target is 90% less than the amount of color measurements of the first printer model (M_a).
2. A printer remodelling method according to the claim 1 wherein the remapping comprising the following steps:
- determining from each color in the color measurements of the second print mode ($m_{s,j}$) a displacement vector ($v_{s,j}$) of the second print mode; and
- interpolating between the displacement vectors ($v_{s,j}$) to displacement vectors from each color in the color measurements of the first printer model ($m_{a,i}$).
3. A printer remodelling method according to anyone of the claims 1 to 2 wherein a displacement vector ($v_{s,j}$) of the second print mode is a vector between the color of the color measurement of the second print mode ($m_{s,j}$) and a color of

the color measurements of the first printer model ($m_{a,i}$) with the same set of colorant values as the color measurement of the second print mode ($m_{s,j}$).

4. A printer remodelling method according to anyone of the claims 1 to 3 wherein the first printer model (M_a) is generated from color measurements of an extended colorant-combination print target.
5. A printer remodelling method according to anyone of the claims 1 to 4 wherein the interpolating is a radial base function (RBF) interpolation method.
6. A printer remodelling method according to anyone of the claim 1 to 5 wherein the printer target comprises:
   - a patch wherein the set of colorant values is located at the boundary of the N-dimensional colorant space of the multi-color printer; and
   wherein the set of colorant values comprises minimum 2 values in the range of]0, $maximum_{colorant}$].
7. A printer remodelling method according to the claim 6 wherein the printer target comprises:
   - a patch wherein the set of colorant values is located at the ink-limitation boundary from the first printer model (M_a).
8. A printer remodelling method according to the claim 7 wherein the printer target comprises:
   - a patch wherein the set of colorant values is the centre of the ink-limitation boundary from the first printer model (M_a).
9. A printer remodelling method according to anyone of the claims 6 to 8 wherein the printer target comprises:
   - a patch wherein only one colorant value of the set of colorant values has a value which is selected from the range]0, $maximum_{colorant}$[.
10. A printer remodelling method according to anyone of the claims 6 to 9 comprising the steps:
    - inverting the first printer model (M_a); and
    - determining a color with a chroma in CIE 1976 L*a*b* smaller than 20; and
    - converting the color by the inverted first printer model (M_a^{-1}) to a set of colorant values ; and
    - assigning a patch in the printer target with the set of colorant values.

11. A printer remodelling method according to the claim 10 comprising the step prior the assigning the set of colorant to a patch:
    - determining the closest set of colorant values from the color measurements ($m_{a,i}$) of the first printer model (M_a) opposite the set of colorant values of the converted color; and
    - assigning a patch in the printer target with the closest set of colorant values.
12. A printer remodelling method according to anyone of the claims 1 to 11 wherein a color measurement comprises spectral values or CIELab-values or CIEXYZ-values.
13. A printer remodelling method according to anyone of the claims 1 to 12 wherein the N-dimensional colorant space comprises minimum two of the following colorants: cyan (C), magenta (M), yellow (Y), black (K), orange (O), green (G), violet (V), red (R), green (G).
14. A printer remodelling method according to anyone of the claims 1 to 13 wherein the printing mode comprises a print characterization selected from substrate characterization, rendering characterization or ink characterization.
15. A printer remodelling method according to anyone of the claims 1 to 14 wherein the multi-color printer is an inkjet printer.

Drawings

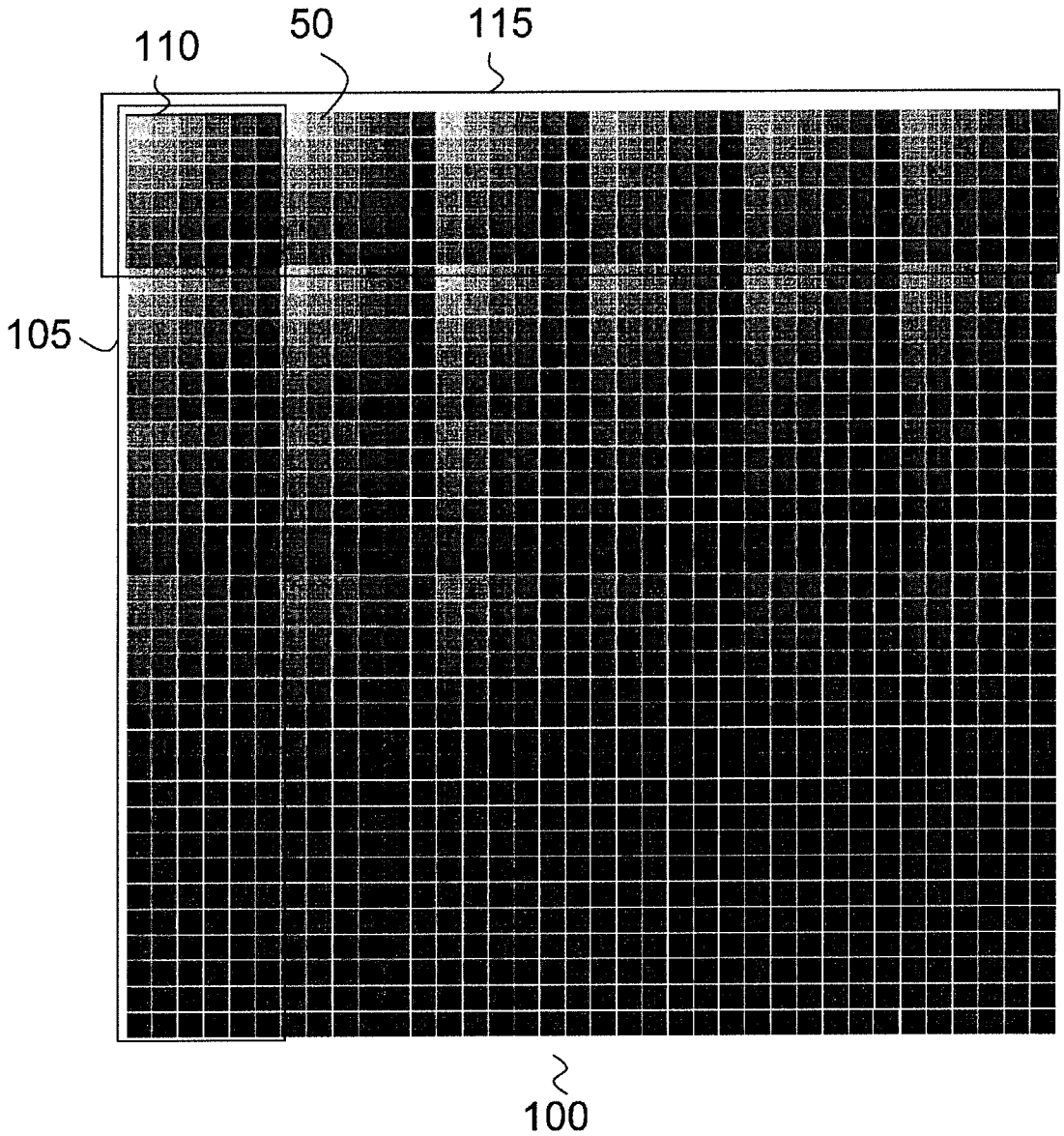


Fig. 1

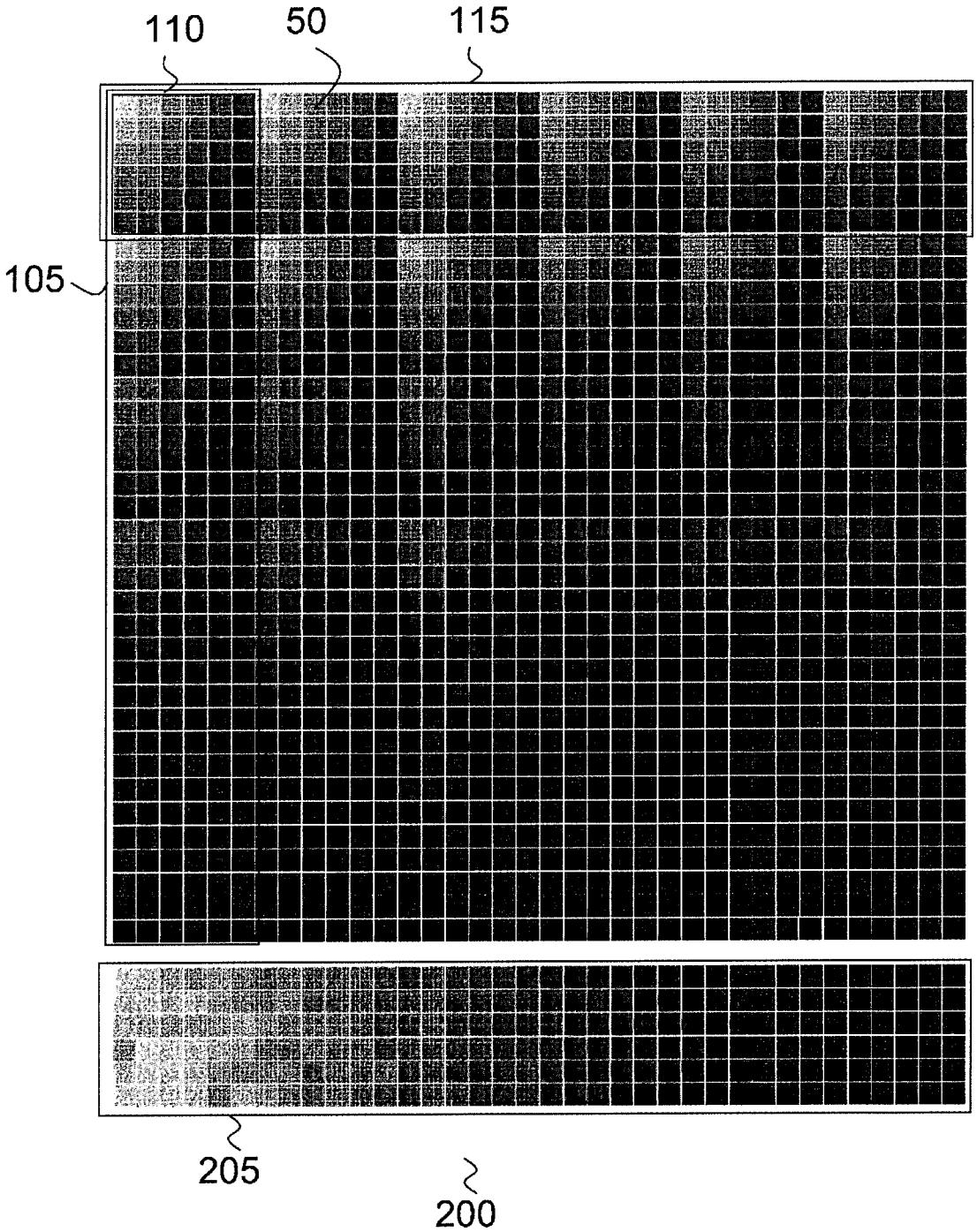


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/052872

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N1/60
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BALASUBRAMANIANO R ET AL: "REFINEMENT OF PRINTER TRANSFORMATION USING WEIGHTED REGRESSION", PROCEEDINGS OF SPIE; [INTELLIGENT VEHICLE HIGHWAY SYSTEMS], S P I E - INTERNATIONAL SOCIETY FOR OPTICAL ENGINEERING, US, vol. 2658, 29 January 1996 (1996-01-29), pages 334-340, XP008020360, ISSN: 0277-786X, DOI: 10.1117/12.236984 ISBN: 978-0-8194-1677-3 the whole document -----	1-15
X	EP 0 747 853 A2 (XEROX CORP [US]) 11 December 1996 (1996-12-11) page 4, line 42 - page 5, line 22 -----	1-15
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 October 2014	23/10/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hardell, Alexander

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/052872

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LITTLEWOOD D ET AL: "Maintaining an accurate printer characterization", COLOR SCIENCE AND ENGINEERING: SYSTEMS, TECHNOLOGIES, APPLICATIONS : FINAL PROGRAM AND PROCEEDINGS OF IS&T AND SID ; THE 12TH COLOR IMAGING CONFERENCE ; NOVEMBER 9 - 12, 2004, SPRINGFIELD, VA. : IS&T, US; SCOTTSDALE, AZ, USA, 1 January 2004 (2004-01-01), pages 203-210, XP008143618, ISBN: 978-0-89208-254-4 the whole document -----	1-15
X	EP 2 299 689 A2 (PALO ALTO RES CT INC [US]) 23 March 2011 (2011-03-23) paragraphs [0025] - [0052] -----	1-15

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2014/052872

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		JP 2011061797 A	24-03-2011
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