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- (54) Title: CONTROL MODULE FOR A PRINTER

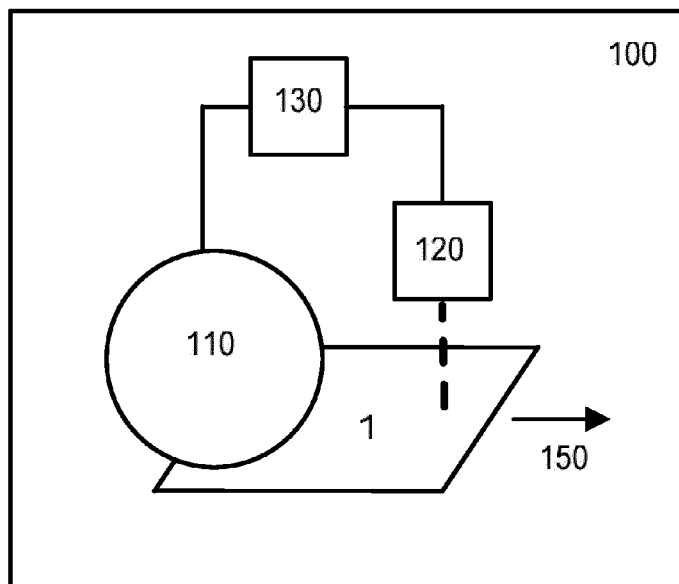


FIG. 2

(57) Abstract: A control module for a printer, the control module comprising: a receiving section to receive information from a measurement section, the information indicative of a size of a first image produced on a medium by an image forming section; and an output section to output control information, the control information to cause the image forming section produce a second image on a subsequent medium, the second image having an adjusted size, the adjustment based on the received information. The medium can be a paper substrate or plastic substrate, and the control module is used for correcting effects of media stretch or shrinkage which may vary over the course of a print run and which may be due to temperature variations.

WO 2014/019604 A1

Control module for a printer

BACKGROUND

5 [0001] Many types of printing devices are known and commonly used, and various printing technologies exist. An example of a printing technology is the digital press, such as the Indigo range from Hewlett-Packard Company.

[0002] Recently print media other than paper are becoming more common. Some of these print media may present new challenges in relation to maintaining image quality.

10 BRIEF DESCRIPTION OF THE DRAWINGS

[0003] Examples are further described hereinafter with reference to the accompanying drawings, in which:

Figure 1 is a graph showing variation in image size with print number throughout a print run.

15 Figure 2 illustrates a printer according to an example.

Figure 3 illustrates a medium with a pattern produced according to an example.

Figure 4 illustrates a control module according to an example.

Figure 5 shows a method according to an example.

Figure 6 shows a method according to an example.

20 Figure 7 shows a comparison between corrected and uncorrected print runs.

DETAILED DESCRIPTION

[0004] The present inventors have discovered that media may stretch or shrink during the printing process, and that the amount of stretching or shrinking may vary over the course of the print run. This variation in size may lead to inconsistencies in image size throughout the print run, possibly leading to unsatisfactory results and wasted prints. In some examples this variation is due to changes in substrate temperature during the print run. The size variation depends on the substrate and its response to temperature, and tends to be greater with plastic substrates, relative to paper substrates. As used herein, print run may refer to a producing the same image a predetermined number of times, e.g. on successive sheets of a medium.

[0005] Figure 1 shows an example of image size throughout a print run by plotting the image length (IL) on the y-axis and print number on the x-axis. A linear fit to the data is also shown.

[0006] In many examples the size variation is limited, or most noticeable, parallel to a path direction of the medium. The path direction is the direction in which the medium is conveyed through the printing apparatus. This is a result of the stress applied to the medium in conveying

it through the printing apparatus.

[0007] Figure 2 is a schematic illustration of a printing device 100 according to an example. The printing device 100 includes an image forming section 110 to produce an image on a medium 1. The medium 1 may be paper, but could be any other suitable print medium, such as a plastic substrate. In the present example, the image forming section is based on liquid ink digital offset technology, but other printing technologies could be used.

[0008] Measurement section 120 is arranged to measure a size of an image produced by the image forming section 110. According to the present example the measurement section 120 measures a length of the image along a path direction 150 of the medium 1, but alternative or additional measures of image size (e.g. an image width or area) may be measured, depending on the image size variation to be corrected. The measurement section 120 may include an inline optical detector arranged to optically detect the image size.

[0009] The printer 100 may be arranged to add a pattern (reference mark or reference marks) to each image, such that the pattern is outside of a main image area. For example, the pattern may be provided in one or more margins between an edge of the main image and an edge of the medium. As used herein, main image may refer to an image on the medium corresponding to image data input by a user, such as a customer image. The pattern may be measured by the measurement section and used to derive a size of the image. The pattern may be arranged to use coloring that is easily detected and distinguished by the measurement section (such as black on white with sharp edges), which may simplify, and/or improve the reliability of, the measurement performed by the measurement section.

[0010] Figure 3 shows an example of a sheet of medium 1 having a main image area 310 containing a main image. In this example, pattern 300 includes three blocks 300a, 300b, 300c located in a margin along a direction parallel to the path direction 150. The three blocks 300a, 300b, 300c may be in an area of the medium 1 with no background color (which may improve detection accuracy), and do not interfere with the main image 310 (as they are in a margin). Each of the three blocks 300a, 300b, 300c may be considered a pattern element. In some examples the measurement section 120 determines a spread, spacing or separation between the pattern elements to derive a size of the image 310. As used herein, determining a size of the image need not imply that the size (e.g. length, width or area) of the main image area 310 is explicitly measured, determined or calculated. It is sufficient that a measure indicative of the size of the main image area 310 is obtained. In some examples this may be the separation between a pair of pattern elements, for example. The example of Figure 3 shows three pattern elements, but two or more may be used. Where more than two pattern elements are used, a measured spacing between pairs of pattern elements may be used to ensure that the measured separations are consistent in order to perform a sanity check. This allows detection and/or

correction of errors in the printing of the pattern or the measurement of the pattern. The measured separation between pairs of pattern elements may be averaged and scaled to produce a measurement indicative of the size of the image. In some examples measured separations between pairs of pattern elements may be used to detect uneven stretching or shrinkage of the medium 1. The pattern elements need not be distinct, provided that they can be individually detected by the measurement section 120. In some examples one or more pattern elements may be used, and the size of the pattern element(s) (e.g. one or more of the length, width, area, etc of the pattern element) may be measured by the measurement section 120. In some examples the measurement section 120 may measure a size of one or more pattern elements as well as a spacing between pairs of pattern elements.

[0011] Pattern elements may be provided at or close to extremes of the main image, this may improve measurement accuracy. For example, in Figure 3 the pattern elements 300a and 300c are provided at opposite ends of the main image in a length direction.

[0012] The result of the measurement by the measurement section 120 is provided to an adjustment section 130. The adjustment section controls the image forming section 110 to adjust a size of a subsequent image, based on the size measured by the measurement section 120. In some examples the adjustment is to make a size of the subsequent image closer to a target size than the size of the image measured by the measurement section 120.

[0013] According to some examples, the adjustment corrects for an initial change in image size, for example the initial drop in image length shown in the first 30 (approx) images of Figure 1. In some examples the initial change in image size may be approximated as substantially linear. In some examples the adjustment may correct for additional image size variation, such as the sinusoidal variation following the initial fall in length shown in Figure 1. For example, an expected contribution to the image size (e.g. due to sinusoidal variation) may be predicted and the adjustment made based at least in part on the prediction. Various linear and non-linear functions may be used to predict the variation, for example by fitting to results obtained from unadjusted test data.

[0014] The adjustment to the size may be an adjustment to a height, a width, or both of the image. In some examples the adjustment is parallel to a path direction 150 of the medium 1. Where the pattern 300 permits measurement along a direction in which adjustment is to be performed, the adjustment may be performed more accurately. However, in some examples an adjustment in one direction may be derived from a measurement in another (e.g. perpendicular) direction, where a relation between the size variations can be estimated (e.g. where the length and width are expected to vary in the same proportion).

[0015] In some examples the target size may be preset as a fixed value. However, in the current example the target size is determined based on measurement of the sizes of one or

more images. For example, the sizes of the first x images of the print run may be measured without performing any size adjustment. An average size over the x images may be determined and used as the target size. In some examples, x may be 10, or around 10.. In some examples only a single image is used (i.e. x=1).

5 **[0016]** In some examples an adjustment for a subsequent image may be based on a predetermined number of previous images. For example, the measured sizes of the immediately preceding y images may be averaged, and the averaged size used to determine an adjustment to be applied to a next image. For example, the average size of the preceding y pages may be taken as the “current” size, and a correction applied based on the difference
 10 between the current size and the target size. A rolling average may be used, such that the nth image is based on images n-y...n-1, and the n+1th image is based on images n-y+1...n. In some examples, the averaging and adjustment are applied in groups, e.g. with an average size being derived based on images n-y...n-1 and the same average size being used to determine the adjustment for all of images n...n+y-1. The adjustment may be fixed for all of these images,
 15 or may vary from image to image in a predetermined manner based on the average size and the print number. In some examples, the number of images used in determining the adjustment need not be the same as the number of images that the adjustment is applied to. In some examples, y may be 2.

[0017] In some examples an adjustment amount may be determined by:

20 **[0018]**
$$Adjustment = \frac{Target}{OldMeasure - Target + NewMeasure} \quad (1)$$

[0019] Where Target is the target size (e.g. page length in microns) and OldMeasure and NewMeasure are previously measured sizes of different pages (e.g. page lengths in microns of sheets n-1 and n, respectively). In some examples the adjustment is to be applied to sheet n, and OldMeasure and NewMeasure respectively represent the sizes of sheets n-1 and n.

25 **[0020]** In this example, the Adjustment is a unit-less parameter that has a value greater than 1 when the adjustment is to increase the image size, and has a value less than 1 when the adjustment is to reduce the image size.

[0021] In some examples a scaling factor may be applied to equation (1).

30 **[0022]** In some examples a plurality of sheets are processed in a pipeline, such that when a sheet is measured by the measurement section 120, a number of subsequent sheets have already been printed.

[0023] In an example with p sheets in the pipeline between the image forming section 110 and the measurement section 120, in which the adjustment is calculated according to equation (1), where OldMeasure and NewMeasure respectively representing the sizes of sheets n-1 and n,

the adjustment would be applied to sheet $n+p$. In some examples $p=12$.

[0024] In some examples the adjustment may be based on (e.g. proportional to) Target - Measure, where Measure is a measured size of a printed sheet (e.g. sheet n).

5 **[0025]** Where the adjustment is derived from an average size of a plurality of sheets, the adjustment may be such that the adjusted image has a size closer than the average size to the target size.

[0026] In some examples no adjustment is performed when the size is determined to be within a predetermined tolerance of the target value.

10 **[0027]** In the present example, the image forming section 110 is based on digital press technology, and the adjustment of the size of the image may be performed by the adjustment section 130 controlling a dynamic mirror of the image forming section 110. However, where other technologies are used, the adjustment section 130 may control the image forming section 110 in a suitable manner.

15 **[0028]** Figure 4 shows a control module 400 according to an example. In some examples, the control module 400 is suitable for use with the printer 100 of Figure 2.

20 **[0029]** The control module 400 includes a receiving section 410 arranged to receive information 415 from a measurement section 120, where the information is indicative of a size of an image formed by an image forming section 110. The control module 400 processes the information and outputs, via an output section 420, control information 425 to control the image forming section to adjust a size of a subsequent image. In some examples, the control module performs the function of the adjustment section 130 of Figure 2. The adjustment produced by the control information 415 may be as described above in relation to Figure 2.

25 **[0030]** Figure 5 shows a method 500 according to an example. The method begins at 510 and proceeds to 520, in which reference marks are printed onto a sheet. A main image may also be printed onto the sheet. Then, at 530, the positions of the reference marks are measured. At 540, the measured positions are compared with predetermined positions. At 550, the size of a subsequent image is adjusted based on the comparison, and at 560 the subsequent image is printed to a sheet. Where, at 570, it is determined that further sheets are to be printed, the method returns to 520, otherwise the method terminates at 580.

30 **[0031]** In some examples, the predetermined positions may be determined based on previously performed measurements of positions of reference marks. For example, the previously performed measurements may have been performed on one or more initial sheets of the print run.

[0032] In relation to Figure 5, references to measured positions and predetermined positions

may include measured relative positions and relative predetermined positions. That is, the positions may be defined relative to other reference marks on the same sheet.

[0033] Figure 6 shows a method 600 according to a further example. The method begins at 610. At 620 size data is collected, for example by a measurement section 120. At 630 the validity of the size data may be confirmed. For example, by checking that the size is greater than zero and less than the size of the sheet. Spacing between multiple pattern elements may also be used to check the validity of the size data. If the sanity tests are passed, the method advances to 640. Otherwise, the method returns to 620. In some examples a user may be alerted or remedial action may be taken when the sanity tests are failed, or when more than a predetermined number of sanity tests are failed.

[0034] In 640 it is determined whether a target has been set. For example, a first portion of the print run, or a first cycle, (e.g. a first predetermined number of images of the print run) may be defined for setting the target. In some examples a number of images in the first cycle (or the number of images used to define the target size) may be based on a total number of images in the print run. Where, at 640, the target is still being set, the method moves to 650 where target setting continues (e.g. by collating size data to generate an average), and then the size data of a next sheet is collected at 620. Where, at 640, it is determined that the target has been set, the method proceeds to 660, where it is determined whether the size of the current image is acceptable. For example, this may involve comparison of the measured size with the target, and determining whether the measured size is within a predetermined tolerance of the target. Where the size is not acceptable, an adjustment is applied at 670 to adjust the size of a subsequent (e.g. the next) image, and the method returns to 620, where size data of the next image is collected (following printing of the image).

[0035] Where the size is determined at 660 to be acceptable, then it is determined, at 680, whether any more sheets are to be printed. Where more sheets are to be printed the method returns to 620. Otherwise, the method terminates at 690. It is to be understood that where portions of Figure 6 that indicate a loop back to 620 (e.g. from 630 and 660) an escape to 690 may be provided in the event that no further sheets are to be printed.

[0036] Figure 7 shows an example of image size (y-axis) against print number (x-axis) for an unadjusted print run plotted as "x" 710, and a print run with size adjustments according to an example of the invention plotted as solid squares 720. Figure 7 also shows the target size used in the adjusted print run, line 730. As is clear from Figure 7, examples of the present invention result in a significant improvement in consistency of the image size over the print run.

[0037] The examples herein contemplate a medium in sheet form, but the medium may be in some other form, such as on a roll.

[0038] Suitable media for use with the examples herein include plastic, transparent, paper, metallic, glossy, matt.

[0039] In the examples the image forming section is based on liquid ink digital offset technology. However, other printing technologies could also be used, such as Ink Jet, Laser Jet, Home Printing devices (simple printers), etc.

[0040] In some examples the functional blocks described herein are not necessarily embodied by distinct components, and in particular components may be shared between functional blocks, and functional blocks may be embodied by a number of cooperating components. Functional blocks may be embodied by processors performing computer-readable instructions. Computer readable instructions may be provided in any suitable volatile or non-volatile storage medium, such as memory, ROM, hard disk, etc. The storage medium may be non-transient.

[0041] Throughout the description and claims of this specification, the words “comprise” and “contain” and variations of them mean “including but not limited to”, and they are not intended to (and do not) exclude other components, integers or steps. Throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

[0042] Features, integers, characteristics or groups described in conjunction with a particular aspect or example of the invention are to be understood to be applicable to any other aspect or example described herein unless incompatible therewith. All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive. The invention is not restricted to the details of any foregoing examples.

CLAIMS

1. A control module for a printer, the control module comprising:
a receiving section to receive information from a measurement section, the information
5 indicative of a size of a first image produced on a medium by an image forming section; and
an output section to output control information, the control information to cause the
image forming section produce a second image on a subsequent medium, the second image
having an adjusted size, the adjustment based on the received information.
- 10 2. A control module according to claim 1, wherein the second image has a size closer to a
target size than the first image.
3. A control module according to claim 2, wherein the target size is based on a size of a
15 previously measured image.
4. A control module according to claim 2, wherein the target size is based on an average
size of a plurality of previously measured images.
5. A control module according to claim 1, wherein the adjustment is based on an average
20 size of a plurality of preceding images, the preceding images including the first image.
6. A control module according to claim 1, further comprising a pattern adding section to add
a pattern to the first and second images, the pattern outside of a main image area of the
images.
25
7. A control module according to claim 6, wherein the pattern is added in a border of the
media parallel to a medium path direction.
8. A control module according to claim 7, wherein the information from the measurement
30 section is indicative of a spacing between elements of the pattern.
9. A control module according to claim 1, wherein the size is an image length parallel to a
medium path, and the adjustment is to the image length.
- 35 10. A control module according to claim 1, wherein the control module is to control a digital
press.

11. A control module according to claim 10, wherein the adjustment is to be performed by adjusting a dynamic mirror in the digital press.
12. A printer comprising:
5 an image forming section to produce images on media;
a measurement section to measure a size of a first image produced by the image forming section;
an adjustment section to adjust the image forming section to change a size of a subsequent image to be formed by the image forming section, the adjustment based on the size
10 measured by the measurement section.
13. The printer of claim 12, wherein the printer is a digital press, and image forming section includes a dynamic mirror, wherein
the adjustment section adjusts the dynamic mirror to change the size of the subsequent
15 image.
14. A method of printing an image on successive sheets of media, comprising:
printing on each sheet a set of reference marks;
measuring the position of the reference marks on each printed sheet;
20 comparing the measured positions to a predetermined position; and
adjusting a size of the image based on the comparison; and
printing the adjusted image.
15. The method of claim 14, further comprising:
25 determining, prior to the comparing, the predetermined position based on the measured positions of the reference marks on one or more of the printed sheets.

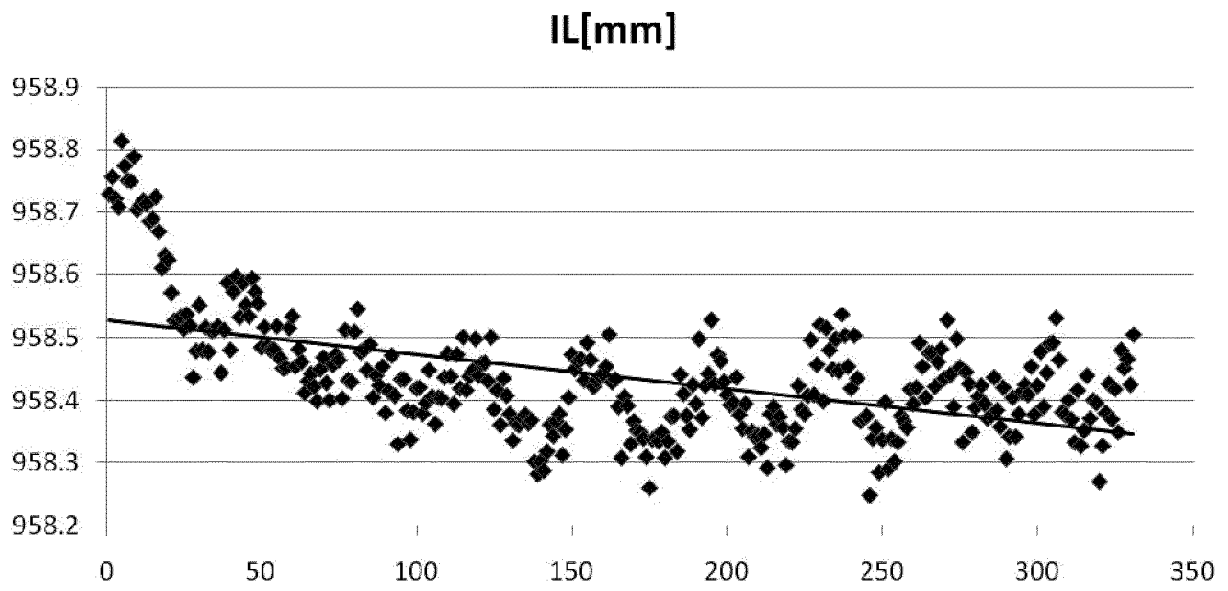


FIG. 1

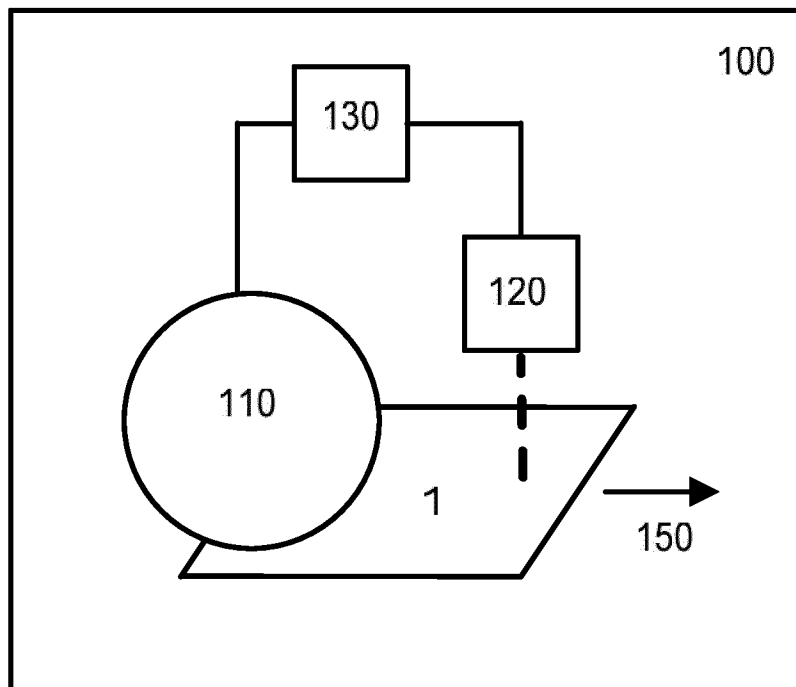


FIG. 2

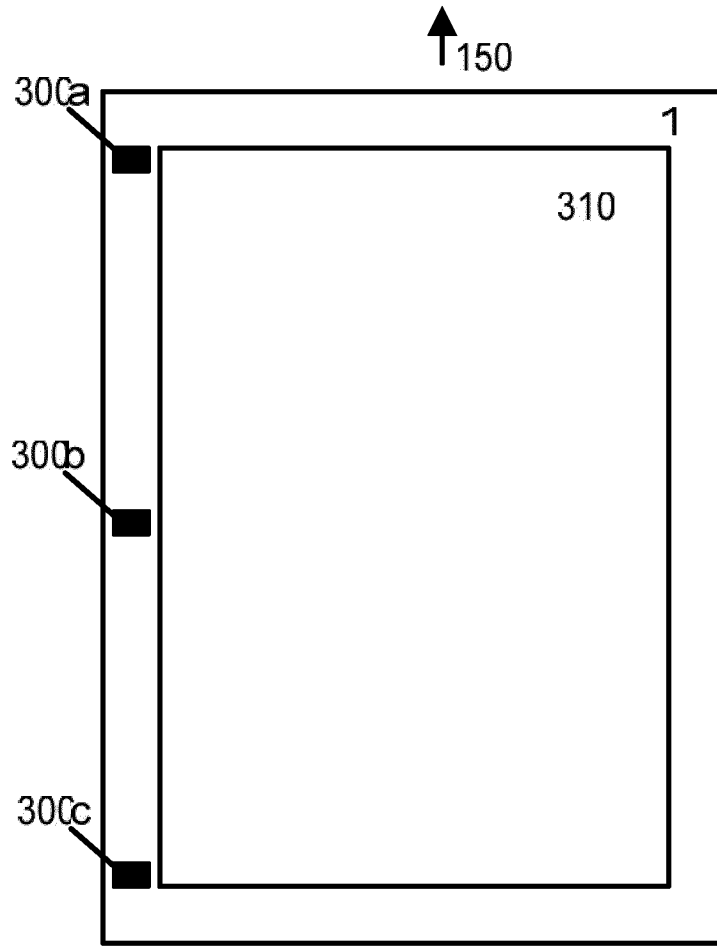


FIG. 3

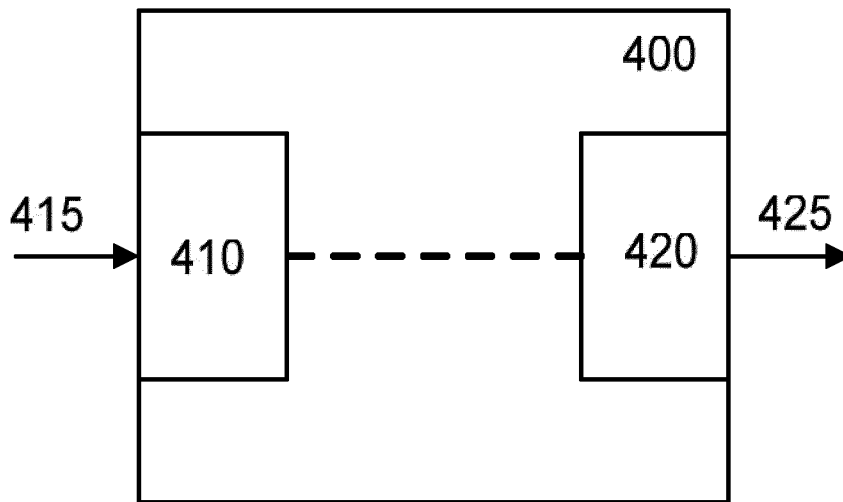


FIG. 4

500

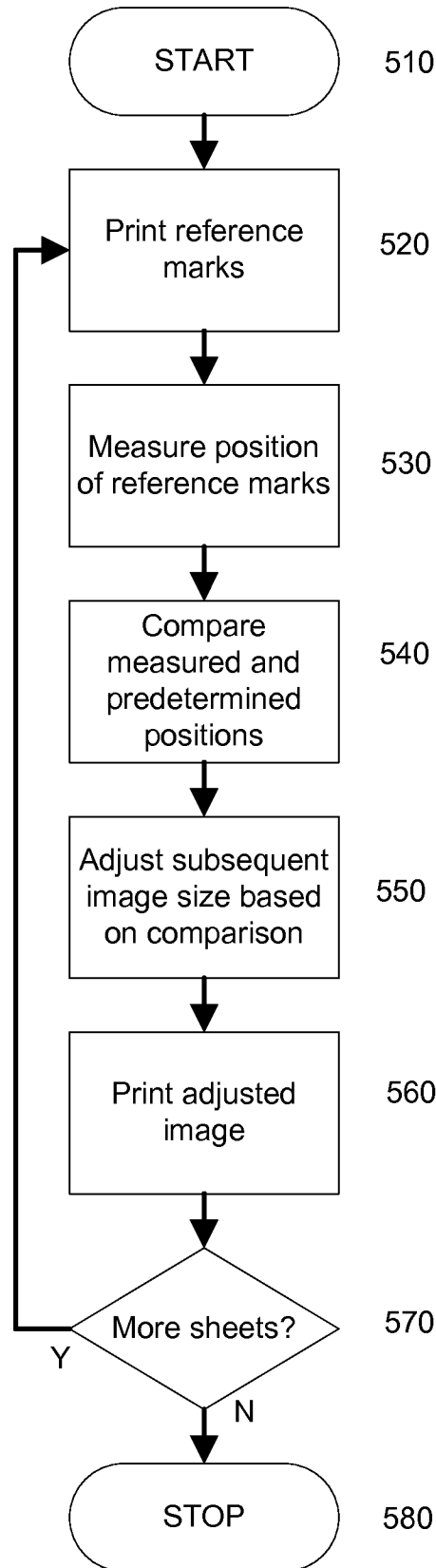


FIG. 5

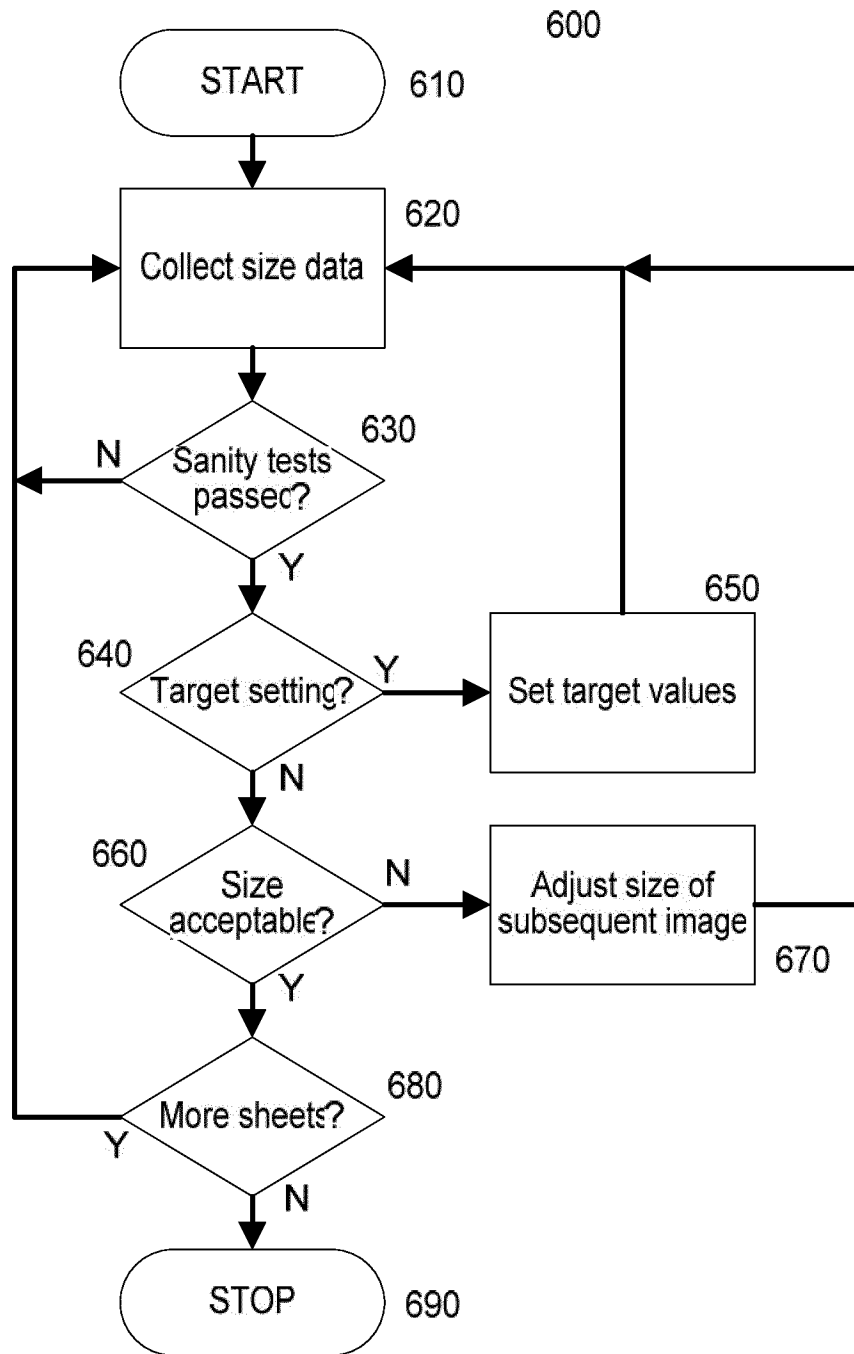


FIG. 6

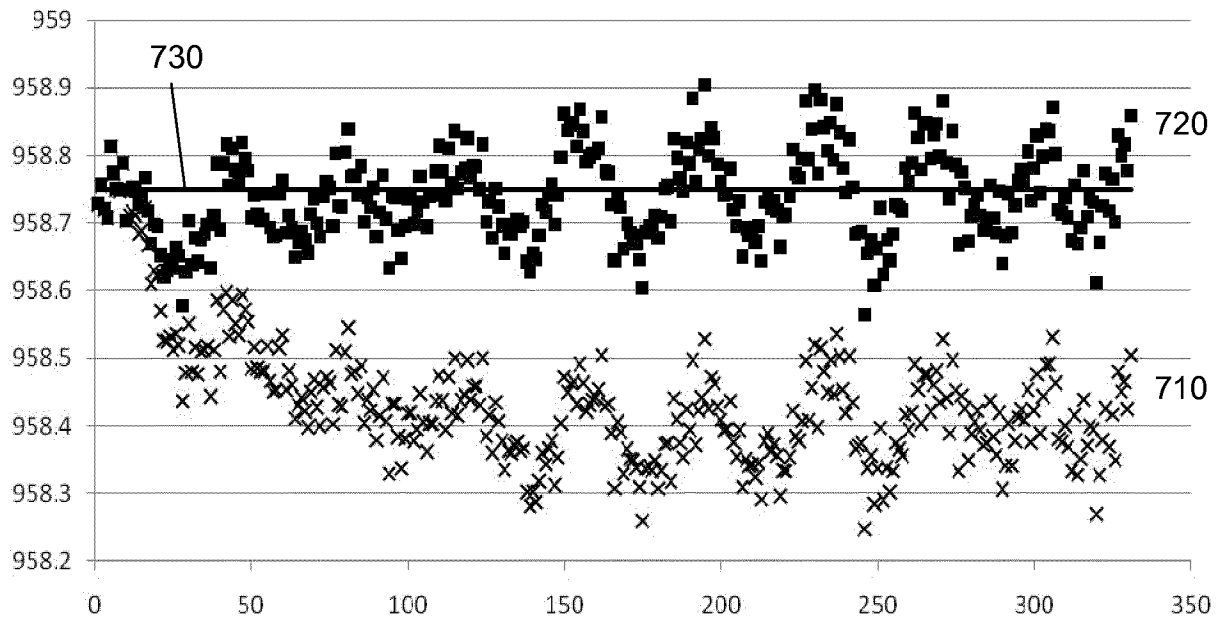


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/064900

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N1/393 H04N1/40
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 G03G

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/102817 A1 (HOOVER MARTIN EDWARD [US] ET AL) 5 May 2011 (2011-05-05) paragraphs [0043] - [0069] -----	1-15
X	US 6 024 504 A (WEICHMANN ARMIN [DE] ET AL) 15 February 2000 (2000-02-15) the whole document -----	1-15
X	US 2005/093956 A1 (EGAN RICHARD G [US]) 5 May 2005 (2005-05-05) paragraphs [0008] - [0100] -----	1-15
A	US 2010/046014 A1 (EUN YONGSOON [US] ET AL) 25 February 2010 (2010-02-25) paragraphs [0004], [0052] -----	1-15

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 15 March 2013	Date of mailing of the international search report 26/03/2013
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Hardell, Alexander
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2012/064900

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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