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(71) Applicant: **AGFA GRAPHICS NV**
2640 Mortsel (BE)

(72) Inventor: **Baeyens, Peter**
2640 Mortsel (BE)

(54) **A reliable calibration method for industrial inkjet systems**

(57) A calibration method for an industrial inkjet system, which comprises printheads ($H_{1,1}, \dots, H_{N,M}$) that are positioned in a matrix, comprising the steps:

- selecting a printhead ($H_{i,j}$), a working parameter for printheads, a sensitive field (F) with a set of P sensitive values ($V_1, \dots, V_P$) which corresponds to the working parameter;
- forming a calibration target by generating for each sensitive value (V_k) of the set of P sensitive values ($V_1, \dots, V_P$) a calibration patch ($P_{i,j,k}$), based on the sensitive value (V_k) wherein the sensitive field (F) is located; and an optical-machine-readable code ($C_{i,j,k}$) to refer to the corre-

sponding patch ($P_{i,j,k}$) and to encode an identification ($I_{i,j}$) of the printhead ($H_{i,j}$) and the sensitive value (V_k);

- jetting the calibration target and selecting a calibration patch ($P_{i,j,r}$) by comparing the calibration patches ($P_{i,j,1}, \dots, P_{i,j,P}$);
- scanning and decoding the optical-machine-readable code ($C_{i,j,r}$), which refers to the selected calibration patch ($P_{i,j,r}$) and adapting a value of the working parameter according to the sensitive value (V_r) and identification ($I_{i,j}$) of the decoded scanned optical-machine-readable code ($C_{i,j,r}$).

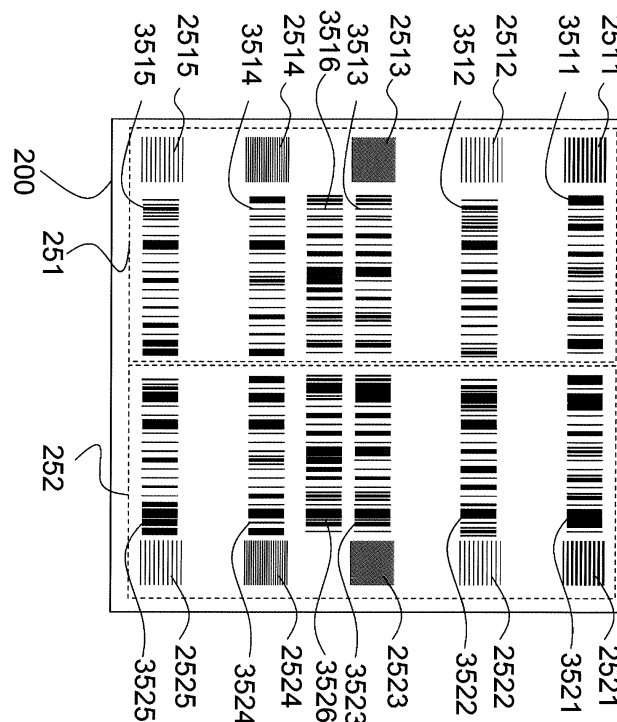


Fig. 5

Description**Technical Field**

5 **[0001]** The present invention relates to a reliable calibration method of a large inkjet printing system, such as an industrial inkjet system.

Background Art

10 **[0002]** The availability of better performing printheads, such as less drop-outs and failing nozzles, and the lower cost of printheads, the maximum printing size of inkjet printing system is enlarged to print on large or multiple ink receivers such as wood or textile. To support these large or multiple ink receivers, a large inkjet printing system has to be manufactured with a large amount of printheads. A maximum use of printheads results in a better productivity (high volume industrial inkjet systems) which is economically beneficial, especially in single pass industrial inkjet systems wherein the width of the printing area covers the total width of the ink receivers.

15 **[0003]** The printing of large ink receivers exists in the state-of-the-art such as the INCA™ Onset S40 or Agfa Graphics™ :M-PRESS TIGER which are capable to handle very large ink receivers for sign& display print jobs and HYMMEN™ JPT-L for printing furniture panels, doors, laminate floorings or façade elements or REGGIANI MACHINE™ ReNOIR for printing on fabric web with a maximum web-width up to 3.40 m or DIEFFENBACHER™ Colorizer for furniture production with formats up to 2.070 mm x 3.600 mm. They have all a large amount of printheads.

20 **[0004]** The availability of better performing printheads, the print quality of industrial inkjet printed objects may also be enhanced by applying more printheads in an industrial inkjet system to enhance the print resolution or to enhance the colour gamut by adding more colors, which results in more heads.

25 **[0005]** In the past industrial inkjet systems had only 4 base colors, (Cyan (C), Magenta (M), Yellow (Y), Black (K)) wherein, whether or not, light colors (light Cyan (Ic), light Magenta (Im)) were added. The colour gamuts in the state-of-the-art industrial inkjet systems are extended with Red (R), Green (G), Violet (V), Purple (P), metallic inks, varnishes, primers and/or spot colors, such as Pantone™ colors which are printed by different printheads.

30 **[0006]** For example Dotrix™ :Transcolor, a duplex single-pass industrial inkjet system had at each side (recto & verso) twenty-four printheads of 150 DPI per color (C,M,Y,K) thus 192 printheads. The Dotrix™ :Transcolor was provided for two additional colors to enlarge the color gamut which resulted in 288 printheads in total to be calibrated. Another example as industrial inkjet system is the ChromoJET MT 4000c x 1024 from ZIMMER™ for printing rugs and carpets with 1024 valve-jets for each of the 16 colors so in total of 16384 valve-jets that have to be calibrated.

35 **[0007]** All these state-of-the-art industrial inkjet printers are complicated to calibrate and all working parameters of the industrial inkjet printer has to be calibrated to have an optimal print quality.

40 **[0008]** For example one of the main factors that determine the print quality of the industrial inkjet printer is the throw distance. The throw distance is defined as the distance from the printhead to the ink receiver. It is a function of many factors including: the jet velocity, the printhead flight path, the variation in jet velocities across the array, nozzle straightness, drive position errors, air turbulence, printhead perpendicularity and alignment, timing errors, and nozzle pitch variation. An industrial inkjet system has several working parameters to control this throw distance which have all to be calibrated for each printhead.

45 **[0009]** The state-of-the-art calibration method of an industrial inkjet system comprises the steps of jetting on an ink receiver a calibration patch for a working parameter; and evaluating the calibration patch for example by a measuring tool or a human visual measurement method, such as viewing by the naked eye; and inputting the result of the evaluation in the industrial inkjet system to adapt a value of the working parameter. In the state-of-the-art calibration methods care have to be taken that an operator doesn't input wrong calibrated values of working parameters by a human input error, such as mistyping. In the calibration method of Agfa Graphics™ :M-PRESS TIGER the input is controlled against a range of values for the working parameter or against values of other working parameters to detect anomalies in the input. For example a calibration patch may be measured by a densitometer to know the maximum density of the jetted ink from a printhead. If the density is too low, a voltage on the printhead is altered to get a darker maximum density. The working parameter is in this example the voltage of a printhead, the density of the calibration patch is a sensitive field. Another example is a calibration patch that comprises a color-on-color registration between two colors by visual evaluating with a microscope. The color-on-color registration can be determined by a distance-difference between the two colors in a pattern of the calibration patch. The color-on-color registration may be corrected by adapting the time-of-firing of the printhead which printed one of the colors in the calibration patch. The time-of-firing of a printhead is a working parameter; the distance difference between two colors is a sensitive field. So a value for a working parameter in the state-of-the-art calibration method is the result of translating the evaluation for a sensitive field, located in a calibration patch.

55 **[0010]** In the state-of-the-art calibration patches for industrial inkjet systems are developed to evaluate fast a calibration

patch by a measurement tool or a visual human measuring method. For example EP0622220 (HEWLETT-PACKARD) discloses a correction of the time-of-fire from a printhead by optical sensing a calibration patch and EP0978390 (HEWLETT-PACKARD) discloses a calibration method for registration purposes of a printhead with a plurality of calibration patches. But still the evaluation of the calibration patches has to be filled in to the industrial inkjet system where human factors may input the evaluation wrongly and more hazardous input the evaluation for the wrong head if the calibration patch was printed to evaluate a working field from a printhead.

[0011] US8118385 (AGFA GRAPHICS) discloses an automation in a calibration method for industrial inkjet systems wherein the calibration patch is scanned to evaluate the calibration patch. This automation is beneficial for a fast calibration method but asks for optical sensors and movement means for the optical sensors. The movement means and the optical sensors are expensive and not sustainable in an industrial printing environment.

[0012] The number of working parameters, especially working parameters of printheads, is in industrial inkjet systems very large so there is a need to have a reliable calibration method to avoid mistakes by the operator who performs the calibration method and there is need to have fast and affordable calibration method. These needs are beneficial for economic reasons to have a fast, payable and correct start-up from the industrial inkjet system.

Summary of invention

[0013] It is an object of the present invention to provide a reliable and fast calibration method for industrial inkjet systems. The object of the invention is realized by the method according to claim 1

[0014] Further advantages and embodiments of the present invention will become apparent from the following description.

Brief description of drawings

[0015]

Figure 1 illustrates a flowchart of a preferred embodiment.

Figure 2 illustrates a flowchart of a preferred embodiment wherein the steps are repeated.

Figure 3 illustrates a flowchart of a preferred embodiment wherein optical-machine-readable code is also generated for intermediate sensitive values without a calibration patch together with step GENCODE (128).

Figure 4 illustrates a part of a calibration target (200) as result of step (FORM) of a preferred embodiment wherein left strip (251) comprises calibration patches (2511, 2512, 2513, 2514, 2515) with immediately adjacent located optical-machine-readable codes (3511, 3512, 3513, 3514, 3515) that refers to the nearby calibration patch in the left strip. The calibration patches in the left strip are printed by a first printhead. The calibration target (200) has also a right strip (252) comprising calibration patches (2521, 2522, 2523, 2524, 2525) with immediately adjacent located optical-machine-readable codes (3521, 3522, 3523, 3524, 3525) that refers to the nearby calibration patch in the right strip (252). The calibration patches in the right strip (252) are printed by a second printhead. In each calibration patch of the left and right strip the same sensitive field (F) is located. The calibration patches (2511, 2512, 2513, 2514, 2515) in the left strip (251) from top to down comprise each a consecutive sensitive value to corresponding sensitive field (F). The calibration patches (2521, 2522, 2523, 2524, 2525) in the right strip (252) from top to down comprise each a consecutive sensitive value to corresponding sensitive field (F).

Figure 5 illustrates a part of a calibration target (200) such as illustrated in figure 4 but wherein in both strips (251, 252) an extra optical-machine-readable code (3516, 3526) is generated which comprises in the left strip (251) the encoding of an intermediate sensitive value of the sensitive values of two calibration patch (2513, 2514) and which comprises in the right strip (252) the encoding of an intermediate sensitive value of the sensitive values of two calibration patch (2523, 2524).

Description of embodiments

[0016] The present invention provides a reliable and fast calibration method for industrial inkjet systems. The industrial inkjet system comprises a plurality of printheads which are mounted and positioned in a matrix of N rows and M columns. The total amount of printheads is larger than one ($M \times N > 1$) and preferably the industrial inkjet systems comprise minimum one row with a plurality of printheads or minimum one column with a plurality of printheads.

[0017] The calibration method for industrial inkjet systems (Figure 1) comprises the steps:

- Selecting a working parameter for printheads of an industrial inkjet system, a sensitive field (F) which corresponds to the working parameter and a printhead (H_{ij}) from the industrial inkjet system (INIT)(100);
- Selecting a set of P sensitive values ($V_1, \dots, V_P$) of the corresponding sensitive field (SELECT)(110) wherein the

number of sensitive values in the set of P sensitive values ($V_1, \dots, V_P$) is larger than one ($P > 1$).

- Forming a calibration target (FORM)(120) by generating for each sensitive value (V_k) of the set of P sensitive values ($V_1, \dots, V_P$):

- a calibration patch ($P_{i,j,k}$), based on the sensitive value (V_k) wherein the sensitive field (F) is located (GEN-PATCH)(124); and
- an optical-machine-readable code ($C_{i,j,k}$) to refer to the corresponding patch ($P_{i,j,k}$) and to encode an identification ($I_{i,j}$) of the printhead ($H_{i,j}$) and the sensitive value (V_k) (GENCODE)(126);

- Jetting the calibration patches in the calibration target on an ink receiver by the selected printhead ($H_{i,j}$) or also by other printheads of the industrial inkjet system (PRINT)(130);
- Selecting a calibration patch ($P_{i,j,r}$) from the jetted calibration target by comparing the calibration patches ($P_{i,j,1}, \dots, P_{i,j,P}$) (COMPARE)(140);
- Scanning the optical-machine-readable code ($C_{i,j,r}$), which refers to the selected calibration patch ($P_{i,j,r}$), as input in the industrial inkjet system (SCAN)(150);
- Decoding (DECODE)(160) the scanned optical-machine-readable code ($C_{i,j,r}$) and adapting (ADAPT)(170) a value of the working parameter of the printhead according to the sensitive value (V_r) and identification ($I_{i,j}$) of the decoded scanned optical-machine-readable code ($C_{i,j,r}$);

wherein the industrial inkjet system comprises printheads ($H_{1,1}, \dots, H_{N,M}$) which are positioned in a matrix with N rows and M columns.

[0018] The calibration method for industrial inkjet systems of the present invention is performed by an industrial inkjet system calibration unit which is comprised in an industrial inkjet system.

[0019] The calibration patches ($P_{i,j,1} \dots P_{i,j,P}$) in the calibration target are evaluated by the operator or service engineer. For this the operator or service engineer may use a microscope or other visualization means and may optionally measure the calibration patches.

[0020] By adding an optical-machine-readable-code to a calibration patch in a calibration target and scanning this optical-machine-readable-code ($P_{i,j,r}$) the method links the encoded identification ($I_{i,j}$) of the printhead and the encoded sensitive value (V_r) to each other to adapt a value of the working parameter correctly for the printhead ($H_{i,j}$) which is identified by the identification ($I_{i,j}$). The value of the working parameter for that printhead ($H_{i,j}$) is adapted by interpreting (INTERPRET) the sensitive value (V_r). This enhances the reliability of calibration method for industrial inkjet systems from the state-of-the-art wherein the input of a sensitive value is not linked with an identification code of a printhead. The operator or service engineer has in the state-of-the-art input itself the sensitive value of the selected calibration patch which may give human errors for example due to inattention. The input of the sensitive values, as in the state-of-art, for a big amount of printheads in an industrial inkjet system may give human errors for example due to boredom and fatigue. The use of optical-machine-readable codes and the scanning of them, makes the calibration method also faster.

[0021] In a preferred embodiment all printheads are mounted in the industrial inkjet system in one printhead unit to position the printheads in a matrix of N rows and M columns or in N parallel printhead units, positioned in rows in the industrial inkjet system, each comprising M printheads or in M parallel printhead units, positioned in columns in the industrial inkjet system, each comprising N printheads. In a preferred embodiment printheads which are positioned in one row or in one column are jetting the same liquid. In another preferred embodiment printheads which are positioned in one row or in one column are jetting the same liquid.

[0022] The calibration method for industrial inkjet systems comprises in a preferred embodiment the steps:

- Selecting a working parameter for printheads of an industrial inkjet system, a sensitive field (F) which corresponds to the working parameter and a plurality of printheads) from the industrial inkjet system (INIT)(100);
- Selecting a set of P sensitive values ($V_1, \dots, V_P$) of the corresponding sensitive field (SELECT)(110) wherein the number of sensitive values in the set of P sensitive values ($V_1, \dots, V_P$) is larger than one ($P > 1$).
- Forming a calibration target (FORM)(120) by generating for each sensitive value (V_k) of the set of P sensitive values ($V_1, \dots, V_P$) and for each printhead in the plurality of printheads:
 - a calibration patch ($P_{i,j,k}$), based on the sensitive value (V_k) wherein the sensitive field (F) is located (GEN-PATCH)(124); and
 - an optical-machine-readable code ($C_{i,j,k}$) to refer to the corresponding patch ($P_{i,j,k}$) and to encode an identification ($I_{i,j}$) of the printhead ($H_{i,j}$) and the sensitive value (V_k) (GENCODE)(126);
 - Jetting the calibration patches in the calibration target on an ink receiver by the selected printhead ($H_{i,j}$) or also by other printheads of the industrial inkjet system (PRINT)(130);

- Selecting a calibration patch ($P_{i,j,r}$) from the jetted calibration target by comparing the calibration patches ($P_{i,j,1}, \dots, P_{i,j,p}$) (COMPARE)(140);
- Scanning the optical-machine-readable code ($C_{i,j,r}$), which refers to the selected calibration patch ($P_{i,j,r}$), as input in the industrial inkjet system (SCAN)(150);
- Decoding (DECODE)(160) the scanned optical-machine-readable code ($C_{i,j,r}$) and adapting (ADAPT)(170) a value of the working parameter of the printhead according to the sensitive value (V_r) and identification ($I_{i,j}$) of the decoded scanned optical-machine-readable code ($C_{i,j,r}$);
wherein the industrial inkjet system comprises printheads $\{H_{1,1}, \dots, H_{N,M}\}$ which are positioned in a matrix with N rows and M columns. In a more preferred embodiment the plurality of printheads are positioned in the same row or column.

[0023] After adapting the value of the working parameter of the printhead according to the sensitive value (V_r) and identification ($I_{i,j}$) of the decoded scanned optical-machine-readable code ($P_{i,j,r}$), the adaption may be reviewed by repeating the steps of calibration method for industrial inkjet systems in the present invention (Figure 2). In a preferred embodiment the set of sensitive values ($V_1, \dots, V_p$) are selected from a range of sensitive values and at repeating the steps of calibration method for industrial inkjet systems embodiment the set of sensitive values ($V_1, \dots, V_p$) are selected from a smaller range of sensitive values to improve the result of the calibration method for industrial inkjet systems at each repeat. The smaller range may be calculated automatically depending on a previous sensitive value of a selected calibration patch. The industrial inkjet system calibration unit may also enlarge the range in a repeat when for example an anomaly in the input or adaption occurred.

[0024] To facilitate the selection of a calibration patch ($P_{i,j,r}$) and the scanning of the optical-machine-readable code ($C_{i,j,r}$) and to minimize human mistakes each optical-machine-readable codes ($C_{i,j,1}, \dots, C_{i,j,p}$) in the calibration target is generated immediately adjacent located to the calibration patch ($P_{i,j,k}$) where the optical-machine-readable code ($C_{i,j,k}$) refers to. If the distance between the optical-machine-readable code ($C_{i,j,r}$) and its selected calibration patch ($P_{i,j,r}$) is too larger, the change of mistaking by the operator becomes larger. For example The time of taking and handling the optical-machine-readable coder to scan the optical-machine-readable code ($C_{i,j,r}$) and time of movement of the optical-machine-readable coder to the optical-machine-readable code ($C_{i,j,r}$) may result in human mistakes due to lost of concentration by the operator. The distance between an optical-machine-readable code and its corresponding calibration patch is preferably between 0 and 100 mm, more preferably between 0 and 50 mm and most preferably between 0 and 20 mm.

[0025] Sometimes the selection of a calibration patch is difficult because two calibration patches, comprising consecutive sensitive values, may both be selected but an intermediate value of the consecutive sensitive values is more preferred by the operator. To keep the dimensions of the calibration target and the number of calibration patches ($P_{i,j,k}$) small, in a preferred embodiment the forming of the calibration target comprises the generation of an optical-machine-readable code, between two optical-machine-readable codes, that both refer to another generated calibration patch; to encode the identification of the printhead ($H_{i,j}$) and a sensitive value between the sensitive values, which are encoded in the two optical-machine-readable codes (Figure 3).

[0026] To optimize the reliability of the present invention, in a preferred embodiment each generated optical-machine-readable code is generated to encode the selected working parameter and/or a value of the selected working parameter. By scanning the optical-machine-readable code ($C_{i,j,r}$) this extra information may be used by the industrial inkjet system calibration unit to verify the input and to enhance the reliability.

[0027] Some working parameters of a printhead are linked to other working parameters of the printhead such as the relation viscosity-temperature and voltage of a printhead. In a preferred embodiment each generated optical-machine-readable code is generated to encode another working parameter of the industrial inkjet system and/or a value of the another working parameter. By scanning the optical-machine-readable code ($C_{i,j,r}$) this extra information may be used to adapt the value of the working parameter according to the sensitive value (V_r) and identification ($I_{i,j}$) of the decoded scanned optical-machine-readable code ($P_{i,j,r}$) and according to the value of the another working parameter or may be used to control for example an anomaly in the input or selection. This preferred embodiment ensures to have a higher reliable calibration method for industrial inkjet systems.

[0028] Any other kind of information may be encoded to the optical-machine-readable code to enhance the reliability of the calibration method for industrial inkjet systems.

[0029] In the present invention an identification ($I_{i,j}$) is encoded in the optical-machine-readable code to know which printhead $H(i,j)$ was used to jet the calibration target. This doesn't mean that the calibration target was printed only with this printhead $H(i,j)$, also other printheads in the industrial inkjet system may be used to jet the calibration target. The identification may comprise the position of the printhead in the printhead unit; type of a printhead; type of inkjet ink in the printhead; and/or color of inkjet ink in the printhead. This information in the identification code in this preferred embodiment enhances the reliability of the calibration method for industrial inkjet systems, for example to prevent that a value of a working parameter from a printhead with cyan ink is changed because the value exceeds the range of printheads with cyan ink. The range of printheads with magenta ink may be different than the range of printheads with

cyan ink. If the industrial inkjet system calibration unit has identified the color of the selected printhead ($H_{i,j}$) mistakes in this preferred embodiment of the calibration method for industrial inkjet systems can be prevented, which enhances the reliability of the method.

[0030] A preferred embodiment further comprises in the scanning-step: inputting a measurement from the selected calibration patch ($P_{i,j,r}$); and wherein the step of adapting a value of the working parameter is according to the measurement, for example the density of the selected calibration patch ($P_{i,j,r}$) may be measured by a densitometer which transmits the density to the industrial inkjet system. The measurement may be used to control the input of the scanned optical-machine-readable code to enhance the reliability of this preferred embodiment. In a more preferred embodiment the measurement is the result of a human visual measuring method, for example the operator or service engineer evaluates or judges the selected calibration patch ($P_{i,j,r}$) by a number in a range or type from a list, such as *{bad, good, best}*, and input his evaluation or judgment in the industrial inkjet system.

[0031] The optical-machine-readable code is in a preferred embodiment insensitive for the selected working parameter else the decoding may be influenced. It may be one-dimensional barcode-type or a two-dimensional barcode-type.

[0032] In a preferred embodiment the calibration patches ($P_{i,j,1} \dots P_{i,j,p}$) of the calibration target is jetted by more than one printhead from the same row or column in the industrial inkjet system and/or the calibration patches ($P_{i,j,1} \dots P_{i,j,p}$) of the calibration target comprises more than one color.

Working parameters and Sensitive fields

[0033] To control a printhead in an industrial inkjet system, several values of parameters have to be determined in a calibration method to obtain an optimal print quality. These parameters that may adapted to obtain an optimal print quality is called working parameters of printheads.

[0034] For example to create pleasing printed images, the dots, printed by a nozzle row in a printhead, must be aligned such that they are closely registered relative to the dots printed by the other nozzle rows. If they are not well registered, then the maximum density attainable by the printer will be compromised, banding artifacts will appear and inferior color registration will lead to blurry or noisy images and overall loss of detail. These problems make good calibration, such as registration and alignment, of all the nozzle rows within an industrial inkjet system critical to ensure good image quality. That is, not only should a nozzle row be well registered with another that jets the same color ink, but it should be well registered with nozzle rows that jet ink of another color.

[0035] In addition to good image quality, faster print rates are desired by customers of industrial inkjet systems such as multi-pass industrial inkjet systems. One way in which nozzle count may be increased is by simply adding extra nozzle rows. This has the advantage that the same printhead design may be used. However, this adds to the number of nozzle rows that must be aligned, thereby increasing the possibility for misalignment and the labour required to properly align all the nozzle rows.

[0036] In multi-pass industrial inkjet systems there are still other considerations that must be made to ensure proper alignment of the nozzle rows. For instance, bi-directional printing in the fast-scan direction to increase productivity requires that the nozzle rows be properly aligned whether travelling in the right-to-left direction or the left-to-right direction.

[0037] Some industrial inkjet systems accept a variety of ink-receiving materials that may differ significantly in thickness. As a result, the industrial inkjet system may have several allowable discrete gaps between the nozzle rows and the printer platen to accommodate these different receivers. Invariably, the gap between the nozzle rows and the top of the receiver, referred to as the throw-distance, can vary significantly because of the range of receiver thicknesses and the limited number of discrete nozzle row heights. Due to the carriage velocity, the flight path of the drop is not straight down but really is the vector sum of the drop velocity and carriage velocity. This angular path and the differences in throw-distance make nozzle row registration sensitive to both the average of throw-distance as well as the variation in the throw-distance. These sensitivities further complicate the nozzle row alignment process.

[0038] Additionally, some multi-pass industrial inkjet systems allow the customer to select different carriage velocities, higher carriage velocities resulting in increased productivity usually at a price in image quality. The term "carriage velocities" implies the supporting of the print heads upon a carriage support that moves in the fast-scan direction while being supported for movement by a rail or other support. The angular flight path of the droplets described will be a function of the carriage velocity. This then makes nozzle row alignment sensitive to the carriage velocity.

[0039] To determine a value for a working parameter, calibration patches are generated wherein a sensitive field (F) is located. The sensitive field shows how the situation is, regarding the calibration of the industrial inkjet system. The situation may be evaluated by the human eye or a measurement device. The calibration patches may be generated with a sensitive value of the sensitive field (F), to know how the calibration shall look like depending on the sensitive value. A sensitive value of a sensitive field (F) simulates a possible print situation in the calibration patch for a value of a working parameter. By selecting the most pleasing calibration patch by comparing other calibration patches comprising the same sensitive field (F), the working parameter, translated from the selected sensitive value in the selected calibration patch, may be adapted to have a better calibration.

[0040] For example, the color-on-color registration can be determined by a distance-difference between the two colors in a pattern of the calibration patch. The color-on-color registration may be corrected by adapting the time-of-firing of the printhead which printed one of the colors in the calibration patch. The time-of-firing of a printhead is a working parameter; the distance difference between two colors is a sensitive field. So a value for a working parameter in the state-of-the-art calibration method is the result of translating the evaluation for a sensitive field, located in a calibration patch.

[0041] More information on sensitive fields and sensitive values are disclosed in US5857784 (BAYER CORP) and US6128090 (AGFA GEVAERT NV).

[0042] The present invention may be used in a landing distance calibration to guarantee dot placement accuracy in bi-directional printing, given the dot speed of the nozzle rows is not the same for all and the height position of the printheads in the printhead unit may be slightly different. Landing distance calibration is done for all each nozzle row in a printhead

[0043] The present invention may be used in a fastscan calibration which is a software / electronic correction of the mechanical fastscan position of each head in the matrix of printheads from the industrial inkjet system.

Calibration target

[0044] A calibration target is preferable defined in raster graphics format such as Portable Network Graphics (PNG), Tagged Image File Format (TIFF), Adobe Photoshop Document (PSD) or Joint Photographic Experts Group (JPEG) or bitmap (BMP) but more preferably a calibration target is defined in a raster vector graphics format, also called line-work format, such as Scale Vector Graphics (SVG) or AutoCad Drawing Exchange Format (DXF) and more preferably defined in a page description language (PDL) such as Printer Command Language (PCL): developed by Hewlett Packard, Postscript (PS): developed by Adobe Systems or Portable Document Format (PDF): developed by Adobe Systems. Preferably the lay-out of the document is created in a desktop publishing (DTP) software package such as Adobe InDesign™, Adobe PageMaker™, QuarkXpress™ or Scribus (<http://scribus.net/canvas/Scribus>).

[0045] A calibration target may be defined in a document markup language, also called mark-up language, such as IBM's Generalized Markup Language (GML) or Standard Generalized Markup Language (ISO 8879:1986 SGML), more preferably defined in HyperText Markup Language (HTML) and most preferably defined in HTML5, the fifth revision of the HTML standard (created in 1990 and standardized as HTML 4 as of 1997) and, as of December 2012, is a candidate recommendation of the World Wide Web Consortium (W3C).

Calibration patch

[0046] In the state-of-the-art many types of patches are disclosed to calibrate printheads such as US5857784 (Bayer Corp) wherein a calibration patch comprises an image position error detection technique which is also applicable by an industrial inkjet system. Visual techniques use calibration patches permit an operator or service engineer to simultaneously view various sensitive values, such as alignment settings, and choose the best calibration patch.

[0047] A calibration patch ($P_{i,j,k}$) in a calibration target is preferable defined in raster graphics format such as Portable Network Graphics (PNG), Tagged Image File Format (TIFF), Adobe Photoshop Document (PSD) or Joint Photographic Experts Group (JPEG) or bitmap (BMP) but more preferably a calibration patch ($P_{i,j,k}$) in a calibration target is defined in a vector graphics format, also called line-work format, such as Scale Vector Graphics (SVG) or AutoCad Drawing Exchange Format (DXF) and more preferably defined in a page description language (PDL) such as Printer Command Language (PCL): developed by Hewlett Packard, Postscript (PS): developed by Adobe Systems or Portable Document Format (PDF): developed by Adobe Systems. Preferably the lay-out of the document is created in a desktop publishing (DTP) software package such as Adobe InDesign™, Adobe PageMaker™, QuarkXpress™ or Scribus (<http://scribus.net/canvas/Scribus>).

[0048] A calibration patch ($P_{i,j,k}$) in a calibration target may be defined in a document markup language, also called mark-up language, such as IBM's Generalized Markup Language (GML) or Standard Generalized Markup Language (ISO 8879:1986 SGML), more preferably defined in HyperText Markup Language (HTML) and most preferably defined in HTML5, the fifth revision of the HTML standard (created in 1990 and standardized as HTML 4 as of 1997) and, as of December 2012, is a candidate recommendation of the World Wide Web Consortium (W3C).

Optical-machine-readable code

[0049] Different types of optical-machine-readable code are well-known, especially in the graphical industry. One of the oldest types of optical-machine-readable code is the one-dimensional barcode. These one-dimensional barcodes are representing the data by varying the widths and spacing's of parallel lines. Barcodes originally were scanned by special optical scanners, called barcode readers. Later, digital imaging devices and interpretive software became avail-

able on devices such as portable mobiles.

[0050] The one-dimensional barcode is nowadays evolved to two-dimensional barcodes, also called matrix barcodes such as the Quick Response Code or QR code. The QR code was first designed for the automotive industry in Japan. A QR code on an item is scanned by a digital imaging device to read the content about the item which it is attached.

[0051] The ability of portable mobiles to scan QR codes makes this type of two-dimensional barcodes popular. For example a QR code, may contain a hyperlink to a web page. Another example is a QR codes, printed on a package, such as pharmaceutical package comprising a medicine, directs the operator of a mobile phone, after the QR code is scanned, to the specifications of the medicine on a web page.

[0052] The optical-machine-readable code is preferably constructed so it is insensitive for changes in working parameters of the industrial inkjet system for example printing by another printhead or printing in another color. The optical-machine-readable code is preferably a two-dimensional barcode-type but more preferably a one-dimensional barcode-type because this type is less insensitive for changes in working parameters.

[0053] An optical-machine-readable code in a calibration target is preferable defined in raster graphics format such as Portable Network Graphics (PNG), Tagged Image File Format (TIFF), Adobe Photoshop Document (PSD) or Joint Photographic Experts Group (JPEG) or bitmap (BMP) but more preferably an optical-machine-readable code in a calibration target is defined in a vector graphics format, also called line-work format, such as Scale Vector Graphics (SVG) or AutoCad Drawing Exchange Format (DXF) and more preferably defined in a page description language (PDL) such as Printer Command Language (PCL): developed by Hewlett Packard, Postscript (PS): developed by Adobe Systems or Portable Document Format (PDF): developed by Adobe Systems. Preferably the lay-out of the document is created in a desktop publishing (DTP) software package such as Adobe InDesign™, Adobe PageMaker™, QuarkXpress™ or Scribus (<http://scribus.net/canvas/Scribus>).

[0054] An optical-machine-readable code in a calibration target may be defined in a document markup language, also called mark-up language, such as IBM's Generalized Markup Language (GML) or Standard Generalized Markup Language (ISO 8879:1986 SGML), more preferably defined in HyperText Markup Language (HTML) and most preferably defined in HTML5, the fifth revision of the HTML standard (created in 1990 and standardized as HTML 4 as of 1997) and, as of December 2012, is a candidate recommendation of the World Wide Web Consortium (W3C).

Graphics

[0055] A raster graphic is also known as a bitmap, contone or a bitmapped graphic and represent a two-dimensional discrete image $P(x,y)$.

[0056] A vector graphic, also known as object-oriented graphic, uses geometrical primitives such as points, lines, curves, and shapes or polygon(s), which are all based on mathematical expressions, to represent an image.

Optical-machine-readable code scanner

[0057] The scanning of the optical-machine-readable code ($C_{i,j,r}$) is performed by an optical-machine-readable code scanner such as optical scanners, barcode readers or digital imaging devices.

[0058] The decoding or interpreting of the scanned optical-machine-readable code ($C_{i,j,r}$) may be done by the optical-machine-readable code scanner or by the industrial inkjet system for example in the industrial inkjet system calibration unit.

[0059] The optical-machine-readable code scanner is preferably mechanically connect to the industrial inkjet system by a wire to transmit the optical-machine-readable code ($C_{i,j,r}$) or to transmit the decoded optical-machine-readable code ($C_{i,j,r}$) to the industrial inkjet system, And more preferably connected by wireless communication such as bluetooth or by a wire-less communication channel such as Bluetooth™, WIFI, radio or microwave communication.

Printhead

[0060] A printhead is a means for jetting an inkjet ink on an ink receiver through a nozzle. The nozzle may be comprised in a nozzle plate (600) which is attached to the printhead. A set of ink channels, comprised in the printhead, corresponds to a nozzle of the printhead which means that the inkjet ink in the set of ink channels can leave the corresponding nozzle in the jetting method. The inkjet ink is preferably an ink, more preferably an UV curable inkjet ink or water based inkjet ink, such as a water based resin inkjet ink

[0061] The way to incorporate printheads into an industrial inkjet system is well-known to the skilled person.

[0062] A printhead may be any type of printhead such as a valvejet printhead, piezoelectric printhead, thermal printhead, a continuous printhead type, electrostatic drop on demand printhead type or acoustic drop on demand printhead type or a page-wide printhead array, also called a page-wide inkjet array.

[0063] A printhead comprises a set of master inlets to provide the printhead with an inkjet ink from a set of external inkjet ink feeding units. Preferably the printhead comprises a set of master outlets to perform a recirculation of the inkjet

ink through the printhead. The recirculation may be done before the droplet forming means but it is more preferred that the recirculation is done in the printhead itself, so called through-flow printheads. The continuous flow of the inkjet ink in a through-flow printhead removes air bubbles and agglomerated particles from the ink channels of the printhead, thereby avoiding blocked nozzles that prevent jetting of the inkjet ink. The continuous flow prevents sedimentation and ensures a consistent jetting temperature and jetting viscosity. It also facilitates auto-recovery of blocked nozzles which minimizes inkjet ink and ink receiver wastage. The recirculation of an inkjet ink results also in less inertia of the inkjet ink. In a more preferred embodiment the printhead is a through-flow piezoelectric printhead or through-flow valvejet printhead, wherein the high viscosity inkjet ink is recirculated in a continuous flow through an inkjet ink transport channel where the pressure to the inkjet ink is applied by a droplet forming means and wherein the inkjet ink transport channel is in contact with the nozzle plate. In a most preferred embodiment the droplet forming means in these printheads applies a pressure in the same direction as the jetting directions towards the ink receiver to activate a straight flow of pressurized inkjet ink to enter the nozzle that corresponds to the droplet forming means. The advantage of such through-flow printheads is a better dot-placement on an ink receiver than the non through-flow printheads for example by less sedimentation in the printhead.

[0064] The number of master inlets in the set of master inlets is preferably from 1 to 12 master inlets, more preferably from 1 to 6 master inlets and most preferably from 1 to 4 master inlets. The set of ink channels that corresponds to the nozzle are replenished via one or more master inlets of the set of master inlets.

[0065] The amount of master outlets in the set of master outlets in a through-flow printhead is preferably from 1 to 12 master outlets, more preferably from 1 to 6 master outlets and most preferably from 1 to 4 master outlets.

[0066] In a preferred embodiment prior to the replenishing of a set of ink channels, a set of inkjet inks is mixed to a jettable inkjet ink that replenishes the set of ink channels. The mixing to a jettable inkjet ink is preferably performed by a mixing means, also called a mixer, preferably comprised in the printhead wherein the mixing means is attached to the set of master inlets and the set of ink channels. The mixing means may comprise a stirring device in an inkjet ink container, such as a manifold in the printhead, wherein the set of inkjet inks are mixed by a mixer. The mixing to a jettable inkjet ink also means the dilution of inkjet inks to a jettable inkjet ink. The late mixing of a set of inkjet inks for jettable inkjet ink has the benefit that sedimentation can be avoided for jettable inkjet inks of limited dispersion stability.

[0067] The inkjet ink leaves the ink channels by a droplet forming means, through the nozzle that corresponds to the ink channels. The droplet forming means are comprised in the printhead. The droplet forming means are activating the ink channels to move the inkjet ink out the printhead through the nozzle that corresponds to the ink channels.

[0068] The amount of ink channels in the set of ink channels that corresponds to a nozzle is preferably from 1 to 12, more preferably from 1 to 6 and most preferably from 1 to 4 ink channels.

[0069] The printhead of the present invention is suitable for jetting an inkjet ink having a jetting viscosity of 5 mPa.s to 3000 mPa.s. A preferred printhead is suitable for jetting an inkjet ink having a jetting viscosity of 20 mPa.s to 200 mPa.s.

Valvejet printhead

[0070] A preferred printhead for the present invention is a so-called Valvejet printhead. Preferred valvejet printheads have a nozzle diameter between 45 and 600 μm . The valvejet printheads comprising a plurality of micro valves, allow for a resolution of 15 to 150 dpi that is preferred for having high productivity while not comprising image quality. A Valvejet printhead is also called coil package of micro valves or a dispensing module of micro valves. The way to incorporate valvejet printheads into an inkjet printing device is well-known to the skilled person. For example, US 2012105522 (MATTHEWS RESOURCES INC) discloses a valvejet printer including a solenoid coil and a plunger rod having a magnetically susceptible shank. Suitable commercial valvejet printheads are chromoJET™ 200, 400 and 800 from Zimmer, Printos™ P16 from VideoJet and the coil packages of micro valve SMLD 300's from Fritz Gyger™ A nozzle plate (600) of a Valvejet printhead is often called a faceplate and is preferably made from stainless steel.

[0071] The droplet forming means of a Valvejet printhead controls each micro valve in the Valvejet printhead by actuating electromagnetically to close or to open the micro valve so that the medium flows through the ink channel. Valvejet printheads preferably have a maximum dispensing frequency up to 3000 Hz.

[0072] In a preferred embodiment the Valvejet printhead the minimum drop size of one single droplet, also called minimal dispensing volume, is from 1 nL (= nanoliter) to 500 μL (= microliter), in a more preferred embodiment the minimum drop size is from 10 nL to 50 μL , in a most preferred embodiment the minimum drop size is from 10 nL to 300 μL . By using multiple single droplets, higher drop sizes may be achieved.

[0073] In a preferred embodiment the Valvejet printhead has a native print resolution from 10 DPI to 300 DPI, in a more preferred embodiment the Valvejet printhead has a native print resolution from 20 DPI to 200 DPI and in a most preferred embodiment the Valvejet printhead has a native print resolution from 50 DPI to 200 DPI.

[0074] In a preferred embodiment with the Valvejet printhead the jetting viscosity is from 5 mPa.s to 3000 mPa.s more preferably from 25 mPa.s to 1000 mPa.s and most preferably from 30 mPa.s to 500 mPa.s.

[0075] In a preferred embodiment with the Valvejet printhead the jetting temperature is from 10 °C to 100 °C more

preferably from 20 °C to 60 °C and most preferably from 25 °C to 50 °C.

Piezoelectric printheads

[0076] Another preferred printhead of the embodiment is a piezoelectric printhead. Piezoelectric printhead, also called piezoelectric inkjet printhead, is based on the movement of a piezoelectric ceramic transducer, comprised in the printhead, when a voltage is applied thereto. The application of a voltage changes the shape of the piezoelectric ceramic transducer to create a void in an ink channel, which is then filled with inkjet ink. When the voltage is again removed, the ceramic expands to its original shape, ejecting a droplet of inkjet ink from the ink channel.

[0077] The droplet forming means of a piezoelectric printhead controls a set of piezoelectric ceramic transducers to apply a voltage to change the shape of a piezoelectric ceramic transducer. The droplet forming means may be a squeeze mode actuator, a bend mode actuator, a push mode actuator or a shear mode actuator or another type of piezoelectric actuator. Suitable commercial piezoelectric printheads are TOSHIBA TEC™ CK1 and CK1L from TOSHIBA TEC™ (<https://www.toshibatec.co.jp/en/products/industrial/inkjet/products/cf1/>) and XAAR™ 1002 from XAAR™ (<http://www.xaar.com/en/products/xaar-1002>).

[0078] An ink channel in a piezoelectric printhead is also called a pressure chamber.

[0079] Between an ink channel and a master inlet of the piezoelectric printheads, there is a manifold connected to store the inkjet ink to supply to the set of ink channels.

[0080] The piezoelectric printhead is preferably a through-flow piezoelectric printhead. In a preferred embodiment the recirculation of the inkjet ink in a through-flow piezoelectric printhead flows between a set of ink channels and the inlet of the nozzle wherein the set of ink channels corresponds to the nozzle.

[0081] In a preferred embodiment in a piezoelectric printhead the minimum drop size of one single jetted droplet is from 0.1 pL to 100 nL, in a more preferred embodiment the minimum drop size is from 1 pL to 150 pL, in a most preferred embodiment the minimum drop size is from 1.5 pL to 15 pL. By using grayscale inkjet head technology multiple single droplets may form larger drop sizes. Minimum drop size of one single jetted droplet may be larger than 50 pL by a piezoelectric printhead, such as the Xaar™ 001 which is used in the digitalization of ceramics manufacturing processes.

[0082] In a preferred embodiment the piezoelectric printhead has a drop velocity from 3 meters per second to 15 meters per second, in a more preferred embodiment the drop velocity is from 5 meters per second to 10 meters per second, in a most preferred embodiment the drop velocity is from 6 meters per second to 8 meters per second.

[0083] In a preferred embodiment the piezoelectric printhead has a native print resolution from 25 DPI to 2400 DPI, in a more preferred embodiment the piezoelectric printhead has a native print resolution from 50 DPI to 2400 DPI and in a most preferred embodiment the piezoelectric printhead has a native print resolution from 150 DPI to 3600 DPI.

[0084] In a preferred embodiment with the piezoelectric printhead the jetting viscosity is from 5 mPa.s to 200 mPa.s more preferably from 25 mPa.s to 100 mPa.s and most preferably from 30 mPa.s to 70 mPa.s.

[0085] In a preferred embodiment with the piezoelectric printhead the jetting temperature is from 10 °C to 100 °C more preferably from 20 °C to 60 °C and most preferably from 30 °C to 50 °C.

[0086] The nozzle spacing distance of the nozzle row in a piezoelectric printhead is preferably from 10 μm to 200 μm; more preferably from 10 μm to 85 μm; and most preferably from 10 μm to 45 μm.

Industrial inkjet system

[0087] An industrial inkjet system is a marking device that is using one or more printhead units wherein one or more printheads are mounted. The printheads jet inkjet ink on an ink receiver. A pattern that is marked by jetting of the industrial inkjet system on an ink receiver is preferably an image. The pattern may be achromatic or chromatic colour. Industrial inkjet system essentially means using inkjet technology as a printing or deposition process in manufacturing or on production lines in a large scale.

[0088] The way to incorporate printheads into an industrial inkjet system is well-known to the skilled person. More information about inkjet systems is disclosed in STEPHEN F. POND. Inkjet technology and Product development strategies. United States of America: Torrey Pines Research, 2000, ISBN 0970086008.

[0089] The industrial inkjet system may mark a broad range of ink receivers: sheet-shaped or web-shaped. An ink receiver may be folding carton, acrylic plates, glass, honeycomb board, corrugated board, foam, medium density fibre-board, solid board, rigid paper board, fluted core board, plastics, aluminium composite material, foam board, corrugated plastic, textile, thin aluminium, paper, rubber, adhesives, vinyl, veneer, varnish blankets, wood, flexographic plates, metal based plates, fibreglass, transparency foils, rugs, carpets or adhesive PVC sheets.

[0090] The industrial inkjet system may comprise a step belt conveyor which is a piece of mechanical handling equipment that carries an ink receiver by moving from a start location to an end location via a porous conveyor belt in successive distance movements, also called discrete step increments. The direction movement from the start location to the end location is called the printing direction or conveying direction. The porous conveyor belt is linked between a plurality of

pulleys wherein the porous conveyor belt rotates around the plurality of pulleys. An example of a general belt conveyor system comprising a vacuum table to hold an ink receiver while printing and wherein the vacuum table comprises pneumatic cleaning devices is disclosed in US 20100271425 (XEROX CORPORATION).

[0091] An industrial inkjet system which prints by a single pass printing process is a preferred embodiment. Such industrial inkjet systems are called industrial single-pass inkjet systems, which can be performed by using page wide inkjet printheads or a printhead unit wherein multiple printheads are staggered to cover the entire width of an ink receiver. In a single pass printing process the inkjet printheads usually remain stationary and the substrate surface is transported once under the inkjet printheads.

[0092] An industrial inkjet system may also comprise a printhead unit, comprising one or more printheads, which is designed for reciprocating back and forth across an ink receiver in a fast scan direction FS and for repositioning across the printing table in a slow scan direction SS perpendicular to the fast scan direction. Printing is done during the reciprocating operation of the printhead unit in the fast scan direction. Optional repositioning of the printhead unit is done in between reciprocating operations of the printhead unit, in order to position the printhead unit in line with a non-printed or only partially printed area of the printing medium. The repositioning of the printhead unit is unnecessary in situations where the printhead unit is equipped to print a full-width printing medium in a single fast scan operation. During the printing, the printing table and supported thereon the printing medium remains in a fixed position. A support frame guides and supports the printhead unit during its reciprocating operation. A printing medium transport system may feed individual ink receivers into the industrial inkjet system along a sheet feeding direction that is substantially perpendicular to the fast scan direction of the printhead unit.

[0093] Alternatively to using a sheet-based medium transport system, e.g. a gripper bar transport system known from automated flat bed screen printing presses, the digital printer may also be used with a web-based medium transport system. The printing medium transport may feed web media into the digital printer from a roll-off at the input end of the digital printer to a roll-on at the discharge end of the digital printer. Inside the digital printer the web is transported along the printing table that is used to support the printing medium during printing. In the particular case of a web-based medium transport with a printing medium feeding direction equal to the slow scan direction, the repositioning of the printhead unit along the slow scan direction may be replaced by a repositioning of the web in the feeding direction. The printhead unit then only reciprocates back and forth across the web in the fast scan direction.

[0094] To have a high productivity the following industrial inkjet system benefits with a large amount of printheads to enhance color gamut, print speed or print resolution:

- The industrial inkjet system that performs the embodiment may be used to create a structure through a sequential layering process by jetting sequential layers, also called additive manufacturing or 3D inkjet printing. So the method of the present invention is preferably comprised in a 3D inkjet printing method. The objects that may be manufactured additively by the embodiment can be used anywhere throughout the product life cycle, from pre-production (i.e. rapid prototyping) to full-scale production (i.e. rapid manufacturing), in addition to tooling applications and post-production customization. Preferably the object jetted in additive layers by the industrial inkjet system is a flexographic printing plate. An example of such a flexographic printing plate manufactured by an industrial inkjet system is disclosed in EP2465678 (AGFA GRAPHICS NV).
- The industrial inkjet system that performs the embodiment may be used to create relief, such as topographic structures on an object, by jetting a sequential set of layers, e.g. for manufacturing an embossing plate. An example of such relief printing is disclosed in US 20100221504 (JOERG BAUER). So the method of the present invention is preferably comprised in a relief inkjet printing method.
- The industrial inkjet system of the embodiment may be used to create printing plates used for computer-to-plate (CTP) systems in which a proprietary inkjet ink is jetted onto a metal base to create an imaged plate (600) from the digital record. So the method of the present invention is preferably comprised in an inkjet computer-to-plate manufacturing method. These plates require no processing or post-baking and can be used immediately after the ink-jet imaging is complete. Another advantage is that platesetters with an industrial inkjet system is less expensive than laser or thermal equipment normally used in computer-to-plate (CTP) systems. Preferably the object that may be jetted by the embodiment is a lithographic printing plate. An example of such a lithographic printing plate (600) manufactured by an industrial inkjet system is disclosed EP1179422 (AGFA GRAPHICS NV).
- Preferably the industrial inkjet system is a textile industrial inkjet system, performing a textile inkjet printing method. In industrial textile industrial inkjet systems, printing on multiple textiles simultaneously is an advantage for producing printed textiles in an economical manner. So the method of the present invention is preferably comprised in a textile printing method by using a printhead.
- Preferably the industrial inkjet system is suitable for manufacturing decorative laminates wherein a paper substrate is jetted with a decoration pattern to form a deco-paper and the deco-paper is impregnated with a thermosetting resin and the impregnated deco-paper is heat pressed upto a decorative laminate.
- Preferably the industrial inkjet system is a ceramic industrial inkjet system, performing a ceramic inkjet printing

method. In ceramic industrial inkjet systems printing on multiple ceramics simultaneously is an advantage for producing printed ceramics in an economical manner. So the method of the present invention is preferably comprised in a printing method on ceramics by using a printhead.

- Preferably the industrial inkjet system is a glass industrial inkjet system, performing a glass inkjet printing method. In glass industrial inkjet systems printing on multiple glasses simultaneous is an advantage for producing printed glasses in an economical manner.
- Preferably the industrial inkjet system is a decoration industrial inkjet system, performing a decoration inkjet printing method, to create digital printed wallpaper, laminate, digital printed objects such as flat workpieces, bottles, butter boats or crowns of bottles.
- Preferably the industrial inkjet system is comprised in an electronic circuit manufacturing system and the method of the present invention is comprised in an electronic circuit manufacturing method wherein the inkjet ink is an inkjet ink with conductive particles, often generally called conductive inkjet ink.

[0095] The industrial inkjet system is preferably a textile industrial inkjet system, ceramic industrial inkjet system, glass industrial inkjet system or decoration industrial inkjet system and on top of more preferably an industrial single-pass inkjet system.

Inkjet ink

[0096] The inkjet ink in the present invention may be any type of ink which is jettable by a printhead. The inkjet ink may be a solvent inkjet ink, UV-curable inkjet ink or dye sublimation inkjet ink.

[0097] An inkjet ink may be a colourless inkjet ink and be used, for example, as a primer to improve adhesion or as a varnish to obtain the desired gloss. However, preferably the inkjet ink includes at least one colorant, more preferably a colour pigment.

[0098] The inkjet ink may be a cyan, magenta, yellow, black, red, green, blue, orange or a spot color inkjet ink, preferable a corporate spot color inkjet ink such as red colour inkjet ink of Coca-Cola™ and the blue colour inkjet inks of VISA™ or KLM™.

[0099] In a preferred embodiment the inkjet ink is an inkjet ink comprising metallic particles or comprising inorganic particles such as a white inkjet ink.

Other embodiments

[0100] The present invention and especially the use of optical-machine-readable codes may also be usefull for other calibration in the industrial inkjet system such as:

- Yaw measurement of the beam whereon a printhead unit is mounted.
- Angle adjustment of a printhead unit which have to be calibrated to be perpendicular to the fastscan movement and therefor also be parallel to the ink receiver movement
- Ink receiver to fastscan calibration: The media is aligned to the media set bar. This bar is mechanically parallel to the beam. The movement of the ink receiver should be perpendicular to the beam in order to obtain a rectangular image. When the media/belt movement is not perpendicular, the image will be slanted into a parallelogram.
- Slowscan adjustment of a printhead unit so the printheads in the printhead unit are proper interlaced positioned.

Reference signs list

100	INIT	3511	Optical-machine readable code
110	SELECT	3512	Optical-machine readable code
120	FORM	3513	Optical-machine readable code
124	GENPATCH	3514	Optical-machine readable code
126	GENCODE	3515	Optical-machine readable code
128	GENCODE	3516	Optical-machine readable code
130	PRINT	3521	Optical-machine readable code
140	COMPARE	3522	Optical-machine readable code

(continued)

150	SCAN	3523	Optical-machine readable code
160	DECODE	3524	Optical-machine readable code
170	ADAPT	3525	Optical-machine readable code
200	Calibration target	3526	Optical-machine readable code
251	Left strip		
2511	Calibration patch		
2512	Calibration patch		
2513	Calibration patch		
2514	Calibration patch		
2515	Calibration patch		
252	Right strip		
2521	Calibration patch		
2522	Calibration patch		
2523	Calibration patch		
2524	Calibration patch		
2525	Calibration patch		

Claims

1. A calibration method for industrial inkjet systems comprising the steps:

a1) selecting a working parameter for printheads of an industrial inkjet system, a sensitive field (F) which corresponds to the working parameter and a printhead ($H_{i,j}$) from the industrial inkjet system;

a2) selecting a set of P sensitive values ($V_1, \dots, V_P$) of the corresponding sensitive field;

b) forming a calibration target by generating for each sensitive value (V_k) of the set of P sensitive values ($V_1, \dots, V_P$):

- a calibration patch ($P_{i,j,k}$), based on the sensitive value (V_k) wherein the sensitive field (F) is located; and
- an optical-machine-readable code ($C_{i,j,k}$) to refer to the corresponding patch ($P_{i,j,k}$) and to encode an identification ($I_{i,j}$) of the printhead ($H_{i,j}$) and the sensitive value (V_k);

c) jetting the calibration target on an ink receiver by the industrial inkjet system;

d) selecting a calibration patch ($P_{i,j,r}$) from the jetted calibration target by comparing the calibration patches ($P_{i,j,1}, \dots, P_{i,j,P}$);

e) scanning the optical-machine-readable code ($C_{i,j,r}$), which refers to the selected calibration patch ($P_{i,j,r}$), as input in the industrial inkjet system;

f) decoding the scanned optical-machine-readable code ($C_{i,j,r}$) and adapting a value of the working parameter of the printhead according to the sensitive value (V_r) and identification ($I_{i,j}$) of the decoded scanned optical-machine-readable code ($C_{i,j,r}$);

wherein the industrial inkjet system comprises printheads ($H_{1,1}, \dots, H_{N,M}$) which are positioned in a matrix with N rows and M columns.

2. A calibration method for industrial inkjet systems according to claim 1

wherein the step a2) is **characterized by** selecting the set of P sensitive values from a first range of sensitive values for the sensitive field (F); and

wherein the steps a2) to f) are repeated with a second range smaller than the first range.

3. A calibration method for industrial inkjet systems according to anyone of the claims 1 or 2 wherein each optical-

machine-readable codes ($C_{i,j,1}, \dots, C_{i,j,p}$) is generated immediately adjacent located to the calibration patch ($P_{i,j,k}$) where the optical-machine-readable code ($C_{i,j,k}$) refers to.

4. A calibration method for industrial inkjet systems according to claim 3 wherein the forming of the calibration target comprises the generation of an optical-machine-readable code, between two optical-machine-readable codes, that both refer to another generated calibration patch; to encode the identification of the printhead ($H_{i,j}$) and a sensitive value between the sensitive values, which are encoded in the two optical-machine-readable codes.
5. A calibration method for industrial inkjet systems according anyone to the claims 1 to 4 wherein each generated optical-machine-readable code is generated to encode the selected working parameter and/or a value of the selected working parameter.
6. A calibration method for industrial inkjet systems according anyone to the claims 1 to 5 wherein each generated optical-machine-readable code is generated to encode another working parameter of the industrial inkjet system and/or a value of the another working parameter.
7. A calibration method for industrial inkjet systems according to anyone of the claims 1 to 6 wherein the identification ($I_{i,j}$) of the printhead ($H_{i,j}$) comprises:
 - the position of the printhead in the printhead unit;
 - type of a printhead;
 - type of inkjet ink in the printhead; and/or
 - color of inkjet ink in the printhead.
8. A calibration method for industrial inkjet systems according to anyone of the claims 1 to 7 wherein step e) further comprises inputting in the industrial inkjet system a measurement from the selected calibration patch ($P_{i,j,r}$); and wherein the step of adapting a value of the working parameter is according to the measurement.
9. A calibration method for industrial inkjet systems according to claim 8 wherein the measurement is the result of a human visual measuring method.
10. A calibration method for industrial inkjet systems according to anyone of the claims 1 to 9 wherein the decoding of the optical-machine-readable code in step f) is insensitive for the selected working parameter.
11. A calibration method for industrial inkjet systems according to anyone of the claims 1 to 10 wherein a generated optical-machine-readable code comprises a one-dimensional barcode-type or a two-dimensional barcode-type.
12. A calibration method for industrial inkjet systems according to anyone of the claims 1 to 11 wherein the calibration patches ($P_{i,j,1} \dots P_{i,j,p}$) of the calibration target is jetted by more than one printhead from the same row or column in the industrial inkjet system.
13. A calibration method for industrial inkjet systems according to claim 12 wherein the calibration patches ($P_{i,j,1} \dots P_{i,j,p}$) of the calibration target comprises more than one color.
14. An industrial inkjet printing method for an industrial inkjet system wherein the industrial inkjet system is calibrated by a calibration method for industrial inkjet systems according to anyone of the claims 1 to 13.
15. An industrial inkjet system comprising a calibration unit which performs a calibration method for industrial inkjet systems according to anyone of the claims 1 to 13.

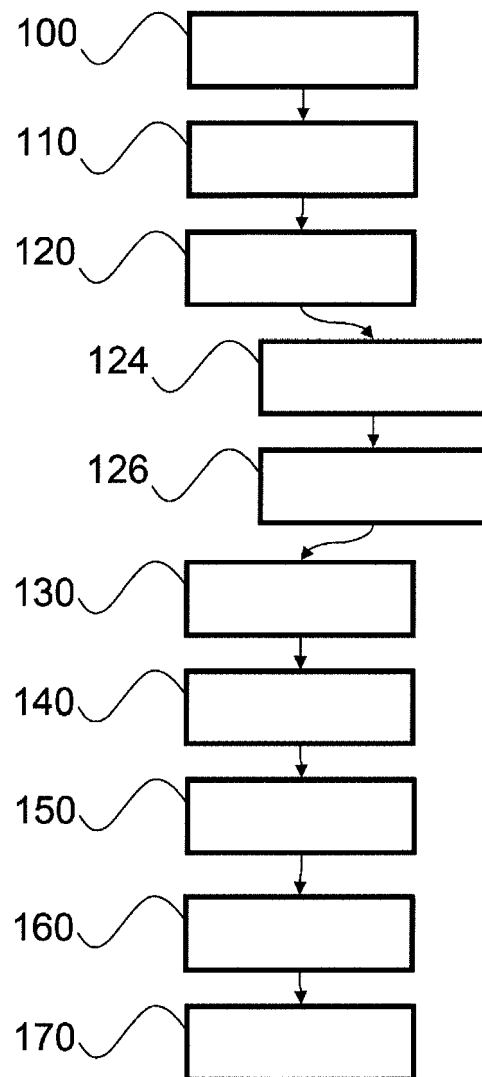


Fig. 1

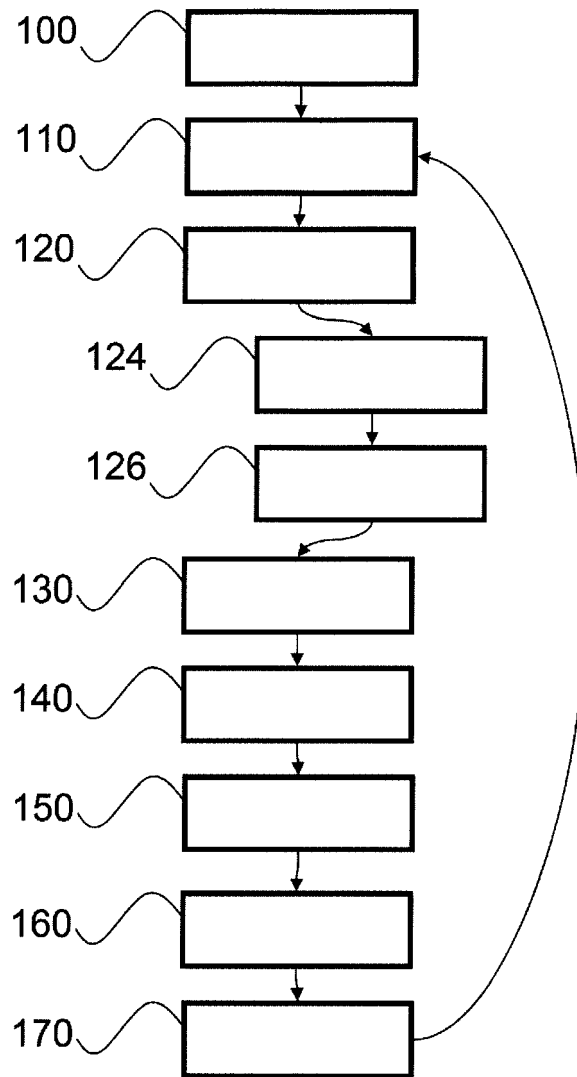


Fig. 2

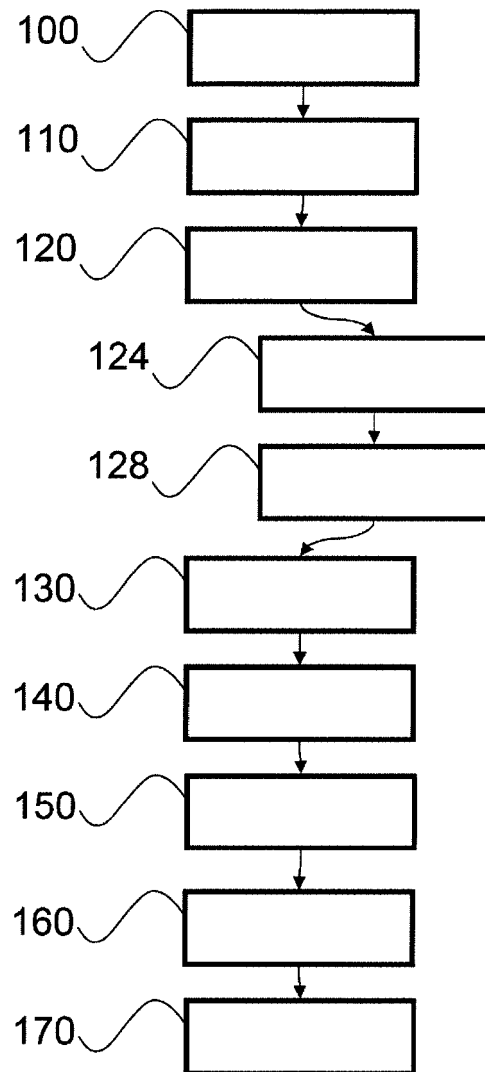


Fig. 3

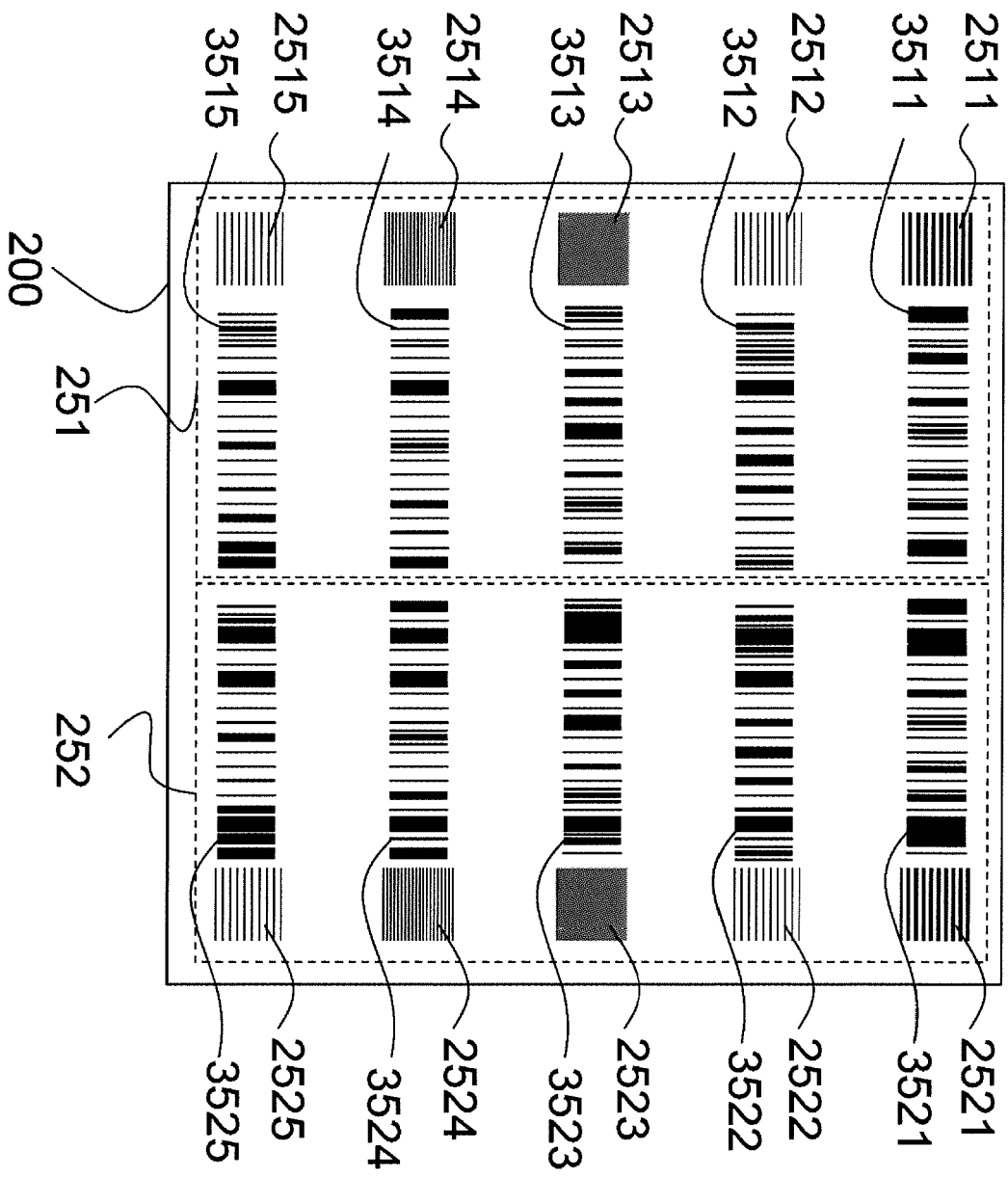


Fig. 4

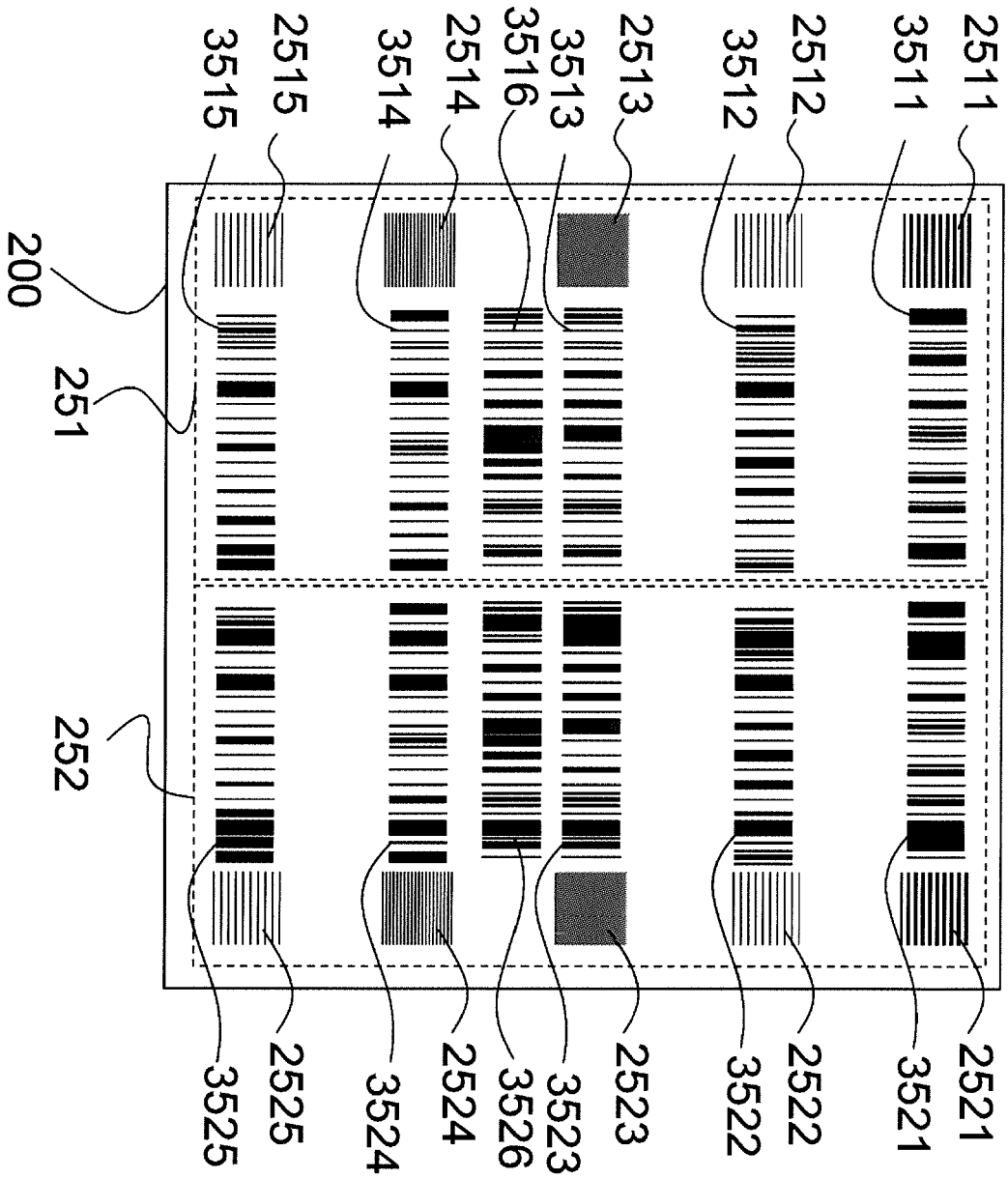


Fig. 5



EUROPEAN SEARCH REPORT

 Application Number
 EP 14 19 6696

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/256877 A1 (TAKAHASHI TORU [JP] ET AL) 15 October 2009 (2009-10-15) * paragraphs [0002], [0004], [0051], [0082] - [0084] *	1-15	INV. B41J29/393
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