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(54)

SHEET EDGE DETECTION DURING UNINTERRUPTED TRANSPORT

- (57)

A sheet edge detection device (20) wherein the signal threshold may be calibrated without interrupting the sheet transport. A detector unit (30) comprising a detector (31) and an emitter (32) emitting at a constant intensity generates signal data as a sheet (S) is transported along the detector (31). While the sheet (S) travels further on a calibration transport path section (CS), a processor (40) processes the signal data to calibrate the signal threshold by deriving a first signal level corresponding to a state wherein no sheet (S) is present between the detector unit (30) and by deriving a second signal level corresponding to a state wherein a sheet (S) covers the detector (31). From said signal levels the signal threshold is derived. This signal threshold is then compared to delayed signal data to determine the position of a point on a sheet edge of the sheet (S) before said sheet (S) reaches the upstream end of the calibration transport section (CS).

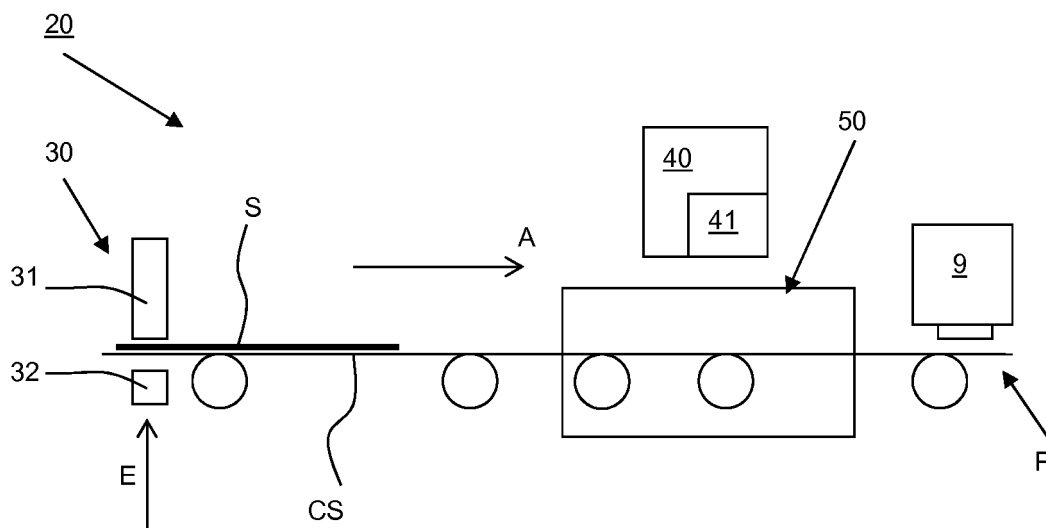


Fig. 2

Description

FIELD OF THE INVENTION

[0001] The present invention generally pertains to a sheet edge detection device, a printing system, as well as to a method for detecting a sheet edge.

BACKGROUND ART

[0002] It is known from e.g. US8179410B2 or US6622625B1 to sense a sheet edge position by means of an optical emitter and an appropriate detector positioned on opposite side of a medium transport path. The print medium passes in between the emitter and detector and the sensed intensity signal generated by the detector is compared to a reference intensity. The moment when the sensed intensity drops below the predetermined threshold, is taken as the time when the medium's leading edge passes the position of the detector. Thereby, the position of the medium's edge can be determined and used e.g. for registering or aligning the medium with respect to an image to be printed on said medium. Due to the differences in transparency or translucency of different media types, the intensity threshold has to be adjusted for each media type for accurate detection of the medium edge. For highly translucent media, the threshold is generally much higher than that of severely opaque media. US8179410B2 or US6622625B1 both disclose a method of determining this intensity threshold by stopping the medium in between the emitter and the detector and then gradually increasing or decreasing the intensity of the light signal emitted by the emitter. A disadvantage of this method is that transport of the media is halted during calibration of the intensity threshold, thereby decreasing the overall productivity of a printing system. This is especially disadvantageous in high productivity cut sheet printing, wherein sheets are printed at rates of 300 sheets per minute or higher. Each sheet may be a different media type, such that temporarily stopping each sheet would severely affect the printing rate.

SUMMARY OF THE INVENTION

[0003] It is an object of the present invention to provide a sheet edge detection device arranged to provide accurate sheet edge detection while allowing for continuous transport of the sheets.

[0004] In a first aspect of the present invention, a sheet edge detection device according to claim 1 is provided.

[0005] The sheet edge detection device according to the present invention comprises:

- a transport path for transporting a sheet to an image forming unit of the printing system, which transport path comprises a calibration transport path section and arranged for transporting sensed sheets to the image forming unit during a calibration of the sheet

edge detection device;

- a detector assembly comprising at least one detector unit positioned upstream of the calibration transport path section, which at least one detector unit comprises an emitter and a detector positioned on opposite sides of the transport path, wherein the at least one detector unit is arranged to generate signal data as a sheet passes the at least one detector unit;
- a processor configured for:
 - receiving signal data from the detector assembly;
 - calibrating a signal threshold by:
 - deriving a first signal level from the signal data corresponding to a state wherein no sheet is present between one of the at least one detector unit;
 - deriving a second signal level from the signal data corresponding to a state wherein a sheet covers the detector of at least one detector unit, as seen in an emission direction from the emitter to the detector;
 - comparing a signal data curve received from a detector assembly to the determined signal threshold to determine an intersection between said signal data curve and said signal threshold;
 - determining the position of a point on a sheet edge of the sheet as said sheet moves over the calibration transport section from the intersection.

[0006] It is the insight of the inventors that the intensity threshold can be calibrated by maintaining a constant emission intensity of the emitter, while the sheet passes the detector. This results in a signal curve from which an upper and lower level, wherein, respectively, no sheet is present over the detector and wherein a sheet covers the detector, can be easily determined. Said levels provide sufficient information for determining a suitable signal threshold.

[0007] The transport path is arranged for continuous or uninterrupted transport of the sheet, such that the sheet moves from the detector unit over the calibration transport path section to the image forming unit without stopping. In a printing system, the calibration transport path section extends between the detector unit and the image forming unit. The calibration transport path section has sufficient length to allow the processor to complete the calibration of the signal threshold and to determine the sheet edge position. At an upstream end of the calibration transport path section, one or more detector units are provided. The emitter and the detector are positioned on opposite sides with respect to a plane of a sheet on the transport path, which in practice would often be above and below the transport path. The emitter is configured to emit an emission signal or emission beam towards the

detector, which emission signal is traversed by the sheets as these are being transported to the calibration transport path section. As the sheet passes the detector, it generates signal data, for example an intensity vs. time curve. In case the signal data comprises a finite set of data points, these data points define a signal data curve, such as intensity vs. time curve. Such a signal curve, in one example, is generated as the leading edge of the sheet moves over the detector. Initially then, the intensity of the signal is relatively high and constant as the detector is free of a sheet. The intensity decreases as the leading edge moves over the detector until the sheet covers the detector. The intensity then becomes constant again, but at a lower level compared to the uncovered state. The signal curve in this example is step-shaped and comprises two plateaus connected by a descending incline. The processor is then able to derive from this signal curve, the first and second signal level corresponding to the fully free and fully covered state (being in this example the plateaus in the signal curve). The signal threshold is then selected to lie in between the first and second signal levels, for example halfway in between said signal levels. This signal threshold can then be used to determine the time when the sheet edge passed the detector by comparing the signal threshold to signal data, which may be either the same signal data curve measured previously or signal data received from a further downstream detector unit. The processor determines an intersection where the signal data curve and the threshold cross or touch each other. Any known means for determining an intersection in data analysis may be used. The intersection has a relatively position within the signal data curve, from which relative position the actual position of the sheet edge on the transport path may be derived. In the example, of the intensity vs. time signal curve, the time axis corresponds to the position of the sheet along the transport. Using the sheet velocity, the time axis can be converted to a position axis. The relative position of the intersection is similarly converted into an actual position by projecting the intersection onto the position or time axis.

[0008] As the first and second signals, the signal threshold, as well the position of the sheet edge can be determined without halting the sheet transport, the object of the present invention has been achieved.

[0009] More specific optional features of the invention are indicated in the dependent claims.

[0010] It will be appreciated that within the scope any known means for data analysis suitable for e.g. defining the signal curve or the intersection. The signal curve may be defined or generated by interpolating or vectorising the data points in the signal data. Any known means to determine an intersection between a signal curve and threshold may be applied. For example, the processor may comprise dedicated comparator circuitry or components as commonly known in electronics. Further, the intersection may be determined by any known mathematical methods to find an intersection between a point

(in case of a threshold point) and curve or between two curves (in case of a threshold curve or line).

[0011] In one embodiment, the processor is configured for determining the position of a point on a sheet edge of the sheet as said sheet moves over the calibration transport section by comparing the signal data received from the at least one detector unit of the detector assembly to the determined signal threshold. The same signal data which is applied to determine the signal threshold is then compared to said threshold to determine the intersection from which the processor derives the sheet edge position. The signal data thus needs to be detected and generated only once for each detector unit in the detector assembly.

[0012] In another embodiment, the sheet edge detection device may further comprise a memory unit for temporarily storing the signal data. The detector transmits the signal data to the memory and to the processor (or only to the processor which transfer the signal then to memory unit). The processor is configured to read data stored on the memory unit. After the processor has completed determining the signal threshold, it reads out the signal data stored in the memory unit to determine the intersection. It is the insight of the inventor that a single detector unit can be used for both calibrating and determining the sheet edge position without interrupting the sheet transport by storing the signal data, such that the same signal data can be used for comparing said signal data to the determined threshold level, which was also determined from said signal data. Both the signal threshold and subsequently the sheet edge position are determined by the processor while the sheet travels over the calibration transport path section. The calibration transport path section provides the processor with the time required to perform the above mentioned determination before the sheet reaches the image forming unit, such that the sheet or the image can be registered before printing on said sheet commences.

[0013] In a further embodiment, the memory unit is configured to store the signal as the sheet passes over the calibration transport path section, such that before the sheet exits the calibration transport path section, the processor has determined the position of the sheet edge by comparing the signal stored on the memory unit to the determined signal threshold. Thus, the calibration transport path section has sufficient length to allow the processor to determine the signal threshold and the sheet edge position of a point on the sheet edge.

[0014] In another embodiment, the detector assembly comprises an upstream detector unit positioned upstream of the calibration transport path and a downstream detector unit positioned along the calibration transport path downstream of the upstream detector unit. The upstream and downstream detector units are spaced apart in the transport direction. First, a sheet edge is sensed by the upstream detector unit after which the sheet moves over the calibration transport path section to the downstream detector unit. The upstream detector

transmits its signal data to the processor. The processor determines the threshold from said signal data while the sheet moves towards the downstream detector. The downstream detector transfers its signal data corresponding to the passage of the sheet (edge) along said downstream detector to the processor. The processor then comprises both the threshold and the signal data, such that these can be compared to determine the intersection and to derive from said intersection the sheet edge position. The processor is then configured for comparing the first signal level and the second signal level from the upstream detector unit to determine the signal threshold. The distance in transport direction between the upstream and downstream detector units is sufficiently long to allow the processor to determine the signal threshold. The processor is then configured to determine a position of a point on a sheet edge of the sheet as said sheet moves over the calibration transport section by comparing the signal data received from the downstream detector unit to the signal threshold determined from the signal data from the upstream detector unit. The sheet edge is then sensed again at the downstream detector unit. This second data set is then compared to the determined signal threshold to determine the sheet edge position. The downstream detector unit allows the sheet edge to be detected close to the image forming unit, such that any re-orientation the sheet undergoes on the calibration transport path section may also be corrected or compensated.

[0015] It will further be appreciated that a sheet herein is defined as a print medium having a trailing and/or leading edge. The invention is particularly advantageous to high volume cut sheet printing, as each cut sheet may be formed of a different medium type. Each sheet then requires its own calibration, which within the present invention may be performed without reducing the productivity. The present invention may further be applied to leading edges of web media, as these are provided from a supply roll to an image forming unit.

[0016] In a further embodiment, the calibration transport path section has a length in a transport direction, which length allows the processor to determine the position of the sheet edge before the sheet edge reaches an upstream end of the calibration transport path. In another embodiment, the calibration transport path section comprises a sheet support surface formed by, e.g., one or more conveyance rollers, a conveyance belt, a sheet support surface or plate for transporting and supporting the sheet from the detector unit to the image forming unit.

[0017] In another embodiment, the edge detection device according to present invention further comprises a transport mechanism for uninterrupted transport of the sheet along and from the detector unit to an upstream end of the calibration transport path section while the processor determines the position of the point on the sheet edge. The transport mechanism is configured to continuously transport the sheet over the calibration transport path section, while the processor determines

the signal threshold and the sheet edge position of a point on the sheet edge. As sheet transport is not temporarily interrupted for calibration purposes, a high productivity level and sheet transport rate (ppm) can be maintained.

The sheet edge detection unit is thus configured for sensing the sheet to generate the signal data, determine the signal threshold, and determine the sheet edge position, all of which are performed during continuous transport of the sheet.

[0018] In an embodiment, the detector of the at least one detector unit is configured to generate a signal curve as a sheet edge passes the detector of the at least one detector unit, and wherein the processor is arranged for:

- deriving a first signal level from the signal curve corresponding to a state wherein no sheet is present between the at least one detector unit;
- deriving a second signal level from the signal curve corresponding to a state wherein the detector of the at least one detector unit is covered by a sheet;
- comparing the first signal level and the second signal level to determine a signal threshold; and
- determining the position of the sheet edge by comparing the signal curve from the detector unit to the determined threshold.

The signal curve or data set is a set of data values or data points, such as a vector or matrix. Preferably, the signal curve comprises an intensity vector comprising data values for the sensed intensities along with a corresponding time vector comprising time data, which indicates the detection time of each of sensed intensities. As explained above, when projected visually, the signal curve will generally be shaped like a step-function, such as an S-curve. The signal curve comprises an upper and a lower plateau, indicating a substantially constant detected intensity over time. The upper plateau corresponds to the detector being free of the sheet, and its intensity level is preferably used as the first signal level. Similarly, the lower plateau corresponds to the detector being covered by a sheet, and may preferably be used as the second signal level. The signal threshold for the received intensity is then set by the processor to lie in between the first and second signal levels. In an efficient embodiment, the processor sets the signal threshold halfway in between the first and second levels, e.g. by dividing the sum of said signal levels by two. The same or a further signal curve for the same sheet is then compared to the threshold to determine the time at which the signal curve crossed the signal threshold. From the determined time or time value, the sheet edge position can be determined, for example by taking into account the sheet velocity and the position of the detector unit. The sheet edge detection device according to the present invention is thus configured to calibrate the signal threshold for each individual sheet in a print job without reducing the print speed. Individual calibration for each sheet increases the accuracy of the sheet edge position and, in turn, its reg-

istration with the printed image. The influence of variations in the intensity of ambient light within sheet edge detection device can thus be minimized. The effect of variations between sheets of the same media type can thus also be reduced or eliminated. The same applies to sheets for duplex printing, whose opacity has been altered by printing on the simplex side of the sheet. In consequence, there is no need to consider the media type for sheet edge detection.

[0019] In a further embodiment, the detector unit comprises a first and a second detector unit, each detector unit laterally spaced apart from one another, each detector unit comprising an emitter and a detector positioned on opposite sides of the transport path, and wherein the processor is configured for:

- determining a first position of a first point on the sheet edge of the sheet from first signal data from the first detector unit;
- determining a second position of a second point on the sheet edge of the sheet from second signal data from the second detector unit;
- determining an orientation of the sheet edge by comparing the first and second positions to one another.

The two points are laterally spaced apart along the sheet edge, i.e. are at a distance from one another in the width direction. By sensing the positions of two points on the sheet edge, the orientation or angle of the sheet edge with respect to a width direction of the transport path can be determined. In consequence, the sheet edge detection device according to the present invention is arranged to determine skewing of the sheet. The sheet edge detection device according to the present invention is preferably further configured to determine the skew angle, which skew angle may be used to correct said skewing by means of a registering device at the downstream end of the calibration transport path. Alternatively, the processor may adjust the digital bitmap image to correct the determined skewing. Thereby, proper alignment of the printed image on the sheet is achieved.

[0020] In another embodiment, the sheet edge detection device according to the present invention comprises a registering device positioned downstream of the calibration transport path section, which registering device is configured to re-orientate the sheet edge in correspondence to the determined position of the sheet edge. The registering device preferably comprises one or more registering rollers or wheels, spaced apart from one another in the width direction of the transport path. By orienting the registering wheels, the sheet may be skewed. Other registering devices, such as a rotatable or skewable suction belt may also be used within the scope of the present invention. In an embodiment, the processor is arranged to control the registering device to re-orientate the sheet edge in correspondence to the determined orientation of the sheet edge. The sheet edge detection device then determines a skew angle parameter and the

processor controls the registering device to rotate the sheet as it moves over the transport path to align the sheet with respect to the image forming unit or the width direction of the transport path.

[0021] In a further embodiment, the emitter of the at least one detector unit is configured to emit an emission signal at a predetermined emission intensity level, at least while the at least one detector unit generates the signal data. The emitter is preferably an optical beam emitter, such as a laser or LED which directs the majority of its light signal in the emission direction. Within the scope of the present invention, the emitter need only emit at a constant intensity when sensing the signal data or curve. A constant emission intensity increases the accuracy of the sheet edge detection device. Such emitters which operate at substantially constant emission levels are relatively cheap and easy to implement. As the present invention allows for sheet-by-sheet calibration any degeneration of the emitted signal intensity over time will not affect the accuracy of the sheet edge detection device according to the present invention.

[0022] In an embodiment, the at least one detection unit comprises an optical emitter which emits an optical beam signal beam in the emission direction to the detector, which is an optical detector. The emitted signal is preferably a beam of e.g. collimated light, such that the majority of the emitted signal is directed towards the detector.

[0023] In another embodiment, the first signal level comprises a top intensity level and the second signal level comprises a bottom intensity level derived from the intensity signal data, such that the signal threshold is an intensity threshold selected to lie in between the top and bottom intensity levels. The top, maximum, or upper signal level preferably is the sensed intensity level when the detector is free of a sheet and the emitted signal is free to travel from the emitter to the detector. The bottom, minimum or lower signal level is the detected signal intensity level when a sheet is present between the emitter and the detector, such that the signal is required to pass through the sheet to reach the detector. During sensing or in the detected signal curve, the intensity level at the top and bottom intensity will be constant over a period of time, as the intensity changes substantially only when an edge of the sheet passes over the detector. In practice, the threshold intensity is then selected in between the top and bottom intensity levels. For example, the intensity threshold may be selected to lie substantially midway or halfway between the top and bottom intensity levels. This allows for a simple and rapid determination of the intensity threshold.

[0024] In a further aspect the present invention provides a printing system, preferably for processing cut sheets, comprising a sheet edge detection device according to the present invention, wherein the calibration transport path section is positioned upstream of an image forming unit of the printing system.

[0025] In another aspect, the present invention pro-

vides a method of determining the position of a point on a sheet edge of a sheet moving through a printing system, the method comprising the steps of:

- transporting a sheet to an image forming unit of the printing system;
- transporting the sheet in between an emitter and detector of at least one detector unit; and while said sheet is being transported to the image forming unit:
 - sensing a first signal level from the signal corresponding to a state wherein no sheet is present between the emitter and the detector of the at least one detector unit;
 - sensing a second signal level from the signal corresponding to a state wherein a sheet covers the detector of the at least one detector unit, as seen in an emission direction from the emitter to the detector;
 - comparing the first signal level and the second signal level to determine a signal threshold; and
 - comparing delayed signal data from at least one detector unit to the determined signal threshold to determine an intersection between said signal data and said signal threshold;
 - determining the position of a point on a sheet edge of the sheet from said intersection.

The delayed signal data may be either stored signal data from the upstream detector unit or signal data generated by the downstream after a delay period. The delay period being sufficiently long to allow the processor to determine the signal threshold.

[0026] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating embodiments of the invention, are given by way of illustration only, since various changes and modifications within the scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying schematical drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

Fig. 1 is a schematic side view of part of a printing system according to an embodiment of the invention; Fig. 2 is a schematic side of a sheet edge detection device according to present invention in the printing system of Fig. 1;

Figs. 3A-F schematically illustrate various steps of a sheet travelling through the sheet edge detection

device of Fig. 2;

Figs. 4A-F schematically illustrate various steps of the signal processing performed sheet edge detection device of Fig. 2 as the sheet travelling through the sheet edge detection device as shown in Figs. 4A-F; and

Fig. 5 illustrates a flow chart showing the different steps of a method according to the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0028] The present invention will now be described with reference to the accompanying drawings, wherein the same reference numerals have been used to identify the same or similar elements throughout the several views.

[0029] With reference to Fig. 1 of the drawings, a portion of an inkjet printing system 1 according to a preferred embodiment of the invention is shown. Fig. 1 illustrates in particular the following parts or steps of the printing process in the inkjet printing system 1: media pre-treatment, image formation, drying and fixing and optionally post treatment. Each of these will be discussed briefly below.

[0030] Fig. 1 shows that a sheet S of a receiving medium or print medium, in particular a machine-coated print medium, is transported or conveyed along a transport path P of the system 1 with the aid of transport mechanism 2 in a direction indicated by arrows P. The transport mechanism 2 may comprise a driven belt system having one or more endless belt 3. Alternatively, the belt(s) 3 may be exchanged for one or more drums. The transport mechanism 2 may be suitably configured depending on the requirements of the sheet transport in each step of the printing process (e.g. sheet registration accuracy) and may hence comprise multiple driven belts 3, 3' and/or multiple drums. For a proper conveyance of the sheets S of the receiving medium or print medium, the sheets S should be fixed to or held by the transport mechanism 2. The manner of such fixation is not limited and may, for example, be selected from the group: electrostatic fixation, mechanical fixation (e.g. clamping) and vacuum fixation, of which vacuum fixation is particularly preferred.

Media pre-treatment

[0031] To improve spreading and pinning (i.e. fixation of pigments and water-dispersed polymer particles) of the ink on the print medium, in particular on slow absorbing media, such as machine-coated media, the print medium may be pre-treated, i.e. treated prior to the printing of an image on the medium.

[0032] Fig. 1 illustrates that the sheet S of print medium may be conveyed to and passed through a first pre-treatment module 4, which module may comprise a preheater, (e.g. a radiation heater), a corona/plasma treatment unit, a gaseous acid treatment unit or a combination of any of these. Subsequently, a predetermined quantity of the

pre-treatment liquid may optionally be applied on a surface of the print medium via a pre-treatment liquid applying device 5. Specifically, the pre-treatment liquid is provided from a storage tank 6 to the pre-treatment liquid applying device 5, which comprises double rollers 7, 7'. A surface of the double rollers 7, 7' may be covered with a porous material, such as sponge. After providing the pre-treatment liquid to auxiliary roller 7' first, the pre-treatment liquid is transferred to main roller 7, and a predetermined quantity is applied onto the surface of the print medium. Thereafter, the coated printing medium (e.g. paper) onto which the pre-treatment liquid was applied may optionally be heated and dried by a dryer device 8, which comprises a dryer heater installed at a position downstream of the pre-treatment liquid applying device 5 in order to reduce the quantity of water content in the pre-treatment liquid to a predetermined range. It is preferable to decrease the water content in an amount of 1.0 weight% to 30 weight% based on the total water content in the pre-treatment liquid provided on the print medium sheet S. To prevent the transport mechanism 2 from being contaminated with pre-treatment liquid, a cleaning unit (not shown) may be installed and/or the transport mechanism 2 may include a plurality of belts or drums 3, 3', as noted above. The latter measure avoids or prevents contamination of other parts of the printing system 1, particularly of the transport mechanism 2 in the printing region.

[0033] It will be appreciated that any conventionally known methods can be used to apply the pre-treatment liquid. Specific examples of an application technique include: roller coating (as shown), ink-jet application, curtain coating and spray coating. There is no specific restriction in the number of times the pre-treatment liquid may be applied. It may be applied just one time, or it may be applied two times or more. An application twice or more may be preferable, as cockling of the coated print medium can be prevented and the film formed by the surface pre-treatment liquid will produce a uniform dry surface with no wrinkles after application twice or more. A coating device 5 that employs one or more rollers 7, 7' is desirable because this technique does not need to take ejection properties into consideration and it can apply the pre-treatment liquid homogeneously to a print medium. In addition, the amount of the pre-treatment liquid applied with a roller or with other means can be suitably adjusted by controlling one or more of: the physical properties of the pre-treatment liquid, the contact pressure of the roller, and the rotational speed of the roller in the coating device. An application area of the pre-treatment liquid may be only that portion of the sheet S to be printed, or an entire surface of a print portion and/or a non-print portion. However, when the pre-treatment liquid is applied only to a print portion, unevenness may occur between the application area and a non-application area caused by swelling of cellulose contained in coated printing paper with water from the pre-treatment liquid followed by drying. From a viewpoint of uniform drying, it is thus preferable

to apply a pre-treatment liquid to the entire surface of a coated printing paper, and roller coating can be preferably used as a coating method to the whole surface. The pre-treatment liquid may be an aqueous liquid.

[0034] Corona or plasma treatment may be used as a pre-treatment step by exposing a sheet of a print medium to corona discharge or plasma treatment. In particular, when used on media such as polyethylene (PE) films, polypropylene (PP) films, polyethylene terephthalate (PET) films and machine coated media, the adhesion and spreading of the ink can be improved by increasing the surface energy of the medium. With machine-coated media, the absorption of water can be promoted which may induce faster fixation of the image and less puddling on the print medium. Surface properties of the print medium may be tuned by using different gases or gas mixtures as medium in the corona or plasma treatment. Examples of such gases include: air, oxygen, nitrogen, carbon dioxide, methane, fluorine gas, argon, neon, and mixtures thereof. Corona treatment in air is most preferred.

Image formation

[0035] When employing an inkjet printer loaded with inkjet inks, the image formation is typically performed in a manner whereby ink droplets are ejected from inkjet heads onto a print medium based on digital signals. Although both single-pass inkjet printing and multipass (i.e. scanning) inkjet printing may be used for image formation, single-pass inkjet printing is preferable as it is effective to perform high-speed printing. Single-pass inkjet printing is an inkjet printing method with which ink droplets are deposited onto the print medium to form all pixels of the image in a single passage of the print medium through the image forming device, i.e. beneath an inkjet marking module.

[0036] Referring to Fig. 1, after pre-treatment, the sheet S of print medium is conveyed on the transport belt 3 to an image forming device or inkjet marking module 9, where image formation is carried out by ejecting ink from inkjet marking device 91, 92, 93, 94 arranged so that a whole width of the sheet S is covered. That is, the image forming device 9 comprises an inkjet marking module having four inkjet marking devices 91, 92, 93, 94, each being configured and arranged to eject an ink of a different colour (e.g. Cyan, Magenta, Yellow and Black). Such an inkjet marking device 91, 92, 93, 94 for use in single-pass inkjet printing typically has a length corresponding to at least a width of a desired printing range R (i.e. indicated by the double-headed arrow on sheet S), with the printing range R being perpendicular to the media transport direction along the transport path P.

[0037] Each inkjet marking device 91, 92, 93, 94 may have a single print head having a length corresponding to the desired printing range R. Alternatively, the inkjet marking device 91 may be constructed by combining two

or more inkjet heads or printing heads, such that a combined length of individual inkjet heads covers the entire width of the printing range R. Such a construction of the inkjet marking device 91 is termed a page wide array (PWA) of print heads.

[0038] In the process of image formation by ejecting ink, an inkjet head or a printing head employed may be an on-demand type or a continuous type inkjet head. As an ink ejection system, an electrical-mechanical conversion system (e.g. a single-cavity type, a double-cavity type, a bender type, a piston type, a shear mode type, or a shared wall type) or an electrical-thermal conversion system (e.g. a thermal inkjet type, or a Bubble Jet® type) may be employed. Among them, it is preferable to use a piezo type inkjet recording head which has nozzles of a diameter of 30 μm or less in the current image forming method.

[0039] The image formation via the inkjet marking module 9 may optionally be carried out while the sheet S of print medium is temperature controlled. For this purpose, a temperature control device 10 may be arranged to control the temperature of the surface of the transport mechanism 2 (e.g. belt or drum 3) below the inkjet marking module 9. The temperature control device 10 may be used to control the surface temperature of the sheet S within a predetermined range, for example in the range of 30°C to 60°C. The temperature control device 10 may comprise one or more heaters, e.g. radiation heaters, and/or a cooling means, for example a cold blast, in order to control and maintain the surface temperature of the print medium within the desired range. During and/or after printing, the print medium is conveyed or transported downstream through the inkjet marking module 9.

Drying and fixing

[0040] After an image has been formed on the print medium, the printed ink must be dried and the image must be fixed on the print medium. Drying comprises evaporation of solvents, and particularly those solvents that have poor absorption characteristics with respect to the selected print medium.

[0041] Fig. 1 of the drawings schematically shows a drying and fixing unit 11, which may comprise one or more heater, for example a radiation heater. After an image has been formed on the print medium sheet S, the sheet S is conveyed to and passed through the drying and fixing unit 11. The ink on the sheet S is heated such that any solvent present in the printed image (e.g. to a large extent water) evaporates. The speed of evaporation, and hence the speed of drying, may be enhanced by increasing the air refresh rate in the drying and fixing unit 11. Simultaneously, film formation of the ink occurs, because the prints are heated to a temperature above the minimum film formation temperature (MFT). The residence time of the sheet S in the drying and fixing unit 11 and the temperature at which the drying and fixing unit 11 operates are optimized, such that when the sheet S

leaves the drying and fixing unit 11 a dry and robust image has been obtained. As described above, the transport mechanism 2 in the fixing and drying unit 11 may be separate from the transport mechanism 2 of the pre-treatment and printing parts or sections of the printing system 1 and may comprise a belt or a drum.

Post treatment

[0042] To improve or enhance the robustness of a printed image or other properties, such as gloss level, the sheet S may be post treated, which is an optional step in the printing process. For example, in a preferred embodiment, the printed sheets S may be post-treated by laminating the print image. That is, the post-treatment may include a step of applying (e.g. by jetting) a post-treatment liquid onto a surface of the coating layer, onto which the ink has been applied, so as to form a transparent protective layer over the printed recording medium. In the post-treatment step, the post-treatment liquid may be applied over the entire surface of an image on the print medium or it may be applied only to specific portions of the surface of an image. The method of applying the post-treatment liquid is not particularly limited, and may be selected from various methods depending on the type of the post-treatment liquid. However, the same method as used in coating the pre-treatment liquid or an inkjet printing method is preferable.

Sheet edge detection

[0043] Fig. 2 illustrates a sheet edge detection device 20 according to the present invention. On the left side, a sheet S is transported via the transport path P to detector unit 30, which generates signal data D. Downstream of the detector unit 30, the calibration transport path section CS extends in the transport direction A to the registering device 50. The processor 40 is arranged to receive the signal data D and derive from that both a signal threshold, to which the signal data D can be compared to determine a position of a point on the sheet edge. Using two or more laterally spaced apart detection units 30 to form a detector assembly, allows the processor 40 to determine the position of two points on the sheet's trailing or leading edge, from which the processor 40 is configured to determine the sheet's orientation. When the processor 40 or controller 40 detects that the sheet S is skewed, meaning that the sensed edge not aligned with e.g. the lateral direction W of the transport path P, the processor 40 instructs the registering device 50 to re-orientate or rotate the sheet S to correct the detected skewing. After de-skewing, the sheet S passes from the registering device 50 to the image forming unit 9. There an image is printed on the de-skewed or registered sheet S. The sheet edge detection device 20 allows for uninterrupted transport of the sheets S, while adjusting the sheet edge detection device 20 in accordance with changes in the media type of the sheets S.

[0044] Fig. 2 shows that each detector unit 30 comprises an emitter 32. The emitter 32 is preferably an optical emitter 32, such as a laser or LED. The optical emitter 32 is oriented to emit a beam-shaped light signal to the detector 31 in the emission direction E, which may a photo-sensor or camera. The detector 31 generates signal data corresponding to the received intensity. The processor 40 or the detector 31 provides for each data point or value in the signal data D, a detection time. Preferably, the signal data D thus comprises a plurality of intensity values together with a plurality of corresponding detection times. The signal data D may e.g. comprise an intensity vector and a corresponding detection time vector.

[0045] The transport mechanism of the printer system 1 is arranged to continuously transport the sheet S over the calibration transport path section CS during the sensing of the sheet S by the detector unit 30 and the consequent processing of the signal data by the processor 40 to determine the sheet edge position. The calibration transport path section CS thus comprises sufficient length for the processor 40 to complete its determination. This allows the processor 40 to timely transmit a registering signal to the registering device 50 to correct the detected skewing of the sheet S proportional to the detected skewing. For example, if the processor device 40 determines the sheet S to be skewed at a skew angle with respect to the lateral direction W of the transport path P, the processor 40 instructs the registering device 40 to rotate the sheet S around an axis perpendicular to the plane of the transport path P. The sheet S is then rotated to eliminate the skew angle, i.e. to align the sheet edge with the lateral direction W of the transport path P or another predefined orientation. To this end, the registering device 50 may comprise means for rotating the sheet S, such as controllable skew correction rollers, a rotatable suction belt, or other known skew correction means. By correcting the skewing, the image printed by image forming unit 9 is properly aligned on the sheet S.

[0046] Figs. 3A-C and Figs. 4A-C illustrate the signal data D as it is being generated by the detector unit 30 when a sheet edge passes along the detector 31. In Fig. 3A, the sheet S is remote from the detector unit 30 and the emitted light from the emitter 32 passes unhindered to the detector 31. The detected intensity level does not substantially change until the sheet edge passes between the emitter 32 and the detector 31. This results in the top plateau on the left side of the signal curve D in Fig. 4A.

[0047] When the sheet edge passes into the space between the emitter 32 and the detector 31, as shown in Fig. 3B, the sensed intensity starts to decrease due to the sheet S gradually blocking off the detector 31. This results in a downward slope in the intensity signal curve D, as shown in Fig. 4B.

[0048] In Fig. 3C, the detector 31 is fully covered by the sheet S. The intensity curve D then reaches its lowest or bottom signal level. This bottom level forms a plateau, as seen on the right hand on Fig. 4C, as the sensed

intensity does not substantially change until the trailing edge of the sheet S reaches the detector 31.

[0049] After, the leading edge of the sheet S departs from the detector 31 onto the calibration transport path section CS, the processor 40 commences the analysis of the signal data D. While the sheet S travels over the calibration transport path section CS, the processor determines a top and bottom signal level L1, L2 from the signal curve D, as shown in Fig. 4D. The top signal level L1 corresponds to the higher intensity level detected when no sheet S was present between the emitter 32 and the detector 31. This top signal level L1 may be easily and rapidly derived from the signal curve D by identifying the higher plateau region at the level L1. Likewise, the processor 40 determines a bottom or lower intensity level L2, which is the intensity when the detector 31 was covered by the sheet S. Again, the lower signal level L2 may be easily determined by identifying the lower plateau region on the right side in Fig. 4D.

[0050] Consequently, while the sheet S travels uninterrupted over the calibration transport path section CS, the processor 40 determines a signal threshold T from the top and bottom signal levels L1, L2, as shown in Fig. 4E. The signal or intensity threshold T is selected to lie between the bottom and top signal levels L1, L2. In Fig. 4E, the signal threshold T is selected midway or halfway between the top and bottom signal levels L1, L2. The signal threshold T is then equidistant from the top and bottom signal levels L1, L2. It will be appreciated that within the scope of present invention the signal threshold T may be selected to be positioned anywhere between the top and bottom signal levels L1, L2.

[0051] The determined signal threshold T is then compared to a signal curve D, as shown in Fig. 4F. As indicated in Fig. 3F, this comparison is performed before the sheet S reaches the end of the calibration transport path CS. The signal curve D may be generated by a further detector unit (not shown) positioned along the calibration transport path CS, but is preferably the same signal data D applied for determining the signal threshold D. In the latter case, this data signal or curve D is stored on a memory unit 41. The memory unit 41 may be any type of known memory unit 41, such a digital storage media such as a hard drive. Preferably, the memory unit 41 comprises a delay circuit connected to the detector 31, such that upon detection one set or copy of the signal data D is transmitted (directly) to the processor 40 for determining the signal threshold D. A second set or copy of the signal data D is delayed, i.e. temporarily stored, via the delay circuit, such that, when the processor 40 has completed determining the signal threshold T, the delayed set of the signal data D is compared to the determined signal threshold T to determine the sheet edge position.

[0052] Fig. 4F show the comparing of the signal data D to the signal threshold T to determine the point of overlap X, where the signal curve D intersects, crosses, matches and/or equals the signal threshold T. It will be

appreciated that the intersecting of the signal curve D and the threshold T may be performed by any known mathematical method for determining an intersection between a curve and a further curve (or a point with a single value, e.g. on the vertical axis). Intersection determining methods such as crossing are commonly known from text books on mathematics, data analysis, and internet sources such as Wikipedia. Equaling is one example of determining an intersection, which is done by finding a value equal to the threshold value in the signal data. Matching may be done similarly but the closest value to or the value falling within a certain range around the threshold value is used. Equaling and matching are commonly known operation in data processing in e.g. Microsoft Excel.

[0053] The intersection X of the signal curve D and the signal threshold T provides the detection time DT, shown along the horizontal axis. The detection time DT provides a measure for the position of the sensed on the sheet edge, for example by multiplying the detection time by the sheet velocity and adding (or subtracting, dependent on the selected positive direction of the respective axis) it the position of the detector unit 30. It will be trivially obvious to the skilled person that a starting point of the signal curve (e.g. a zero time on its time axis) may be randomly selected as long as this is done in relation to the sheet position within the printing system. The processor 40 selects the sheet position through the printing system 1 by means of sheet detectors and/or determining its travelling distance from its travel time and velocity. The starting point of the signal data D is selected such that detector unit 30 starts generating signal data before the arrival of the leading edge of the sheet at said detector unit 30. So, a sufficiently large time or distance factor is selected by an operator or the processor to ensure the detector unit 30 is recorded data D well before the arrival of the sheet. In a basic example, the printing system 1 inputs sheets with a specific inter-sheet spacing between two consecutive sheets. For example, the detector unit 30 may begin generating data Da time period after the trailing edge of a sheet has passed the detector unit 30. The time period may be zero or a fraction (e.g. half) of the inter-sheet spacing divided by the sheet velocity.

[0054] To determine skewing of the sheet S, the present invention provides two or more detector units 30 spaced laterally (i.e. in the width direction W of the transport path P) apart from one another. Each detector unit 30 provides signal data D for a point on the sheet edge. Thus, the positions of at least two points on the edge can be determined, from which the orientation or skewing of the sheet S may be determined. Using more than two detector units 30 may further increase the accuracy of the skew detection. The determined skewing, which is preferably in the form of a skew angle, is used to control the registering device 50 to correct skewing of the sheet S. The registering device 50 in Fig. 2 comprises steerable roller pairs to correct skewing, but other means such as a rotatable suction belt may be applied. In this manner,

accurate skew detection may be performed without halting sheets S, thereby improving the productivity of the printing system 1.

[0055] Fig. 5 shows an embodiment of a method according to the present invention. In step i, the processor or controller 40 controls the transport mechanism to transport the sheets S along the transport path P. The controller 40 controls the transport mechanism to continuously transport the sheets S, during the duration of the print job. As the controller or processor 40 controls the sheet transport through the printing system 1, the position of the sheet within the printing system 1 is known at all times to the processor 40, however at a low or reduced accuracy. The processor 40 tracks the sheet by determining its travelling distance from its velocity (which is controlled by the processor 40) and travel time since input. Dimensions of the paper path are therein used and incidental sheet detectors may be implemented along the path to occasionally verify and/or correct the sheet position. For the majority of the paper path the accuracy of this tracking is sufficient, but at e.g. the print heads 9 or at a sheet registration device a greater accuracy is required. The printing at the print heads needs to start at a precise moment after arrival of the sheet S to properly position the image on the sheet S. Likewise, when correcting a skewing or lateral shifting of the sheet S by the sheet registration, precise knowledge of the initial orientation of the sheet S is required, such that the sheet S can be rotated and/or shifted into its proper position. Hence, the detector unit 30 may be positioned upstream of and near by the print heads 9 or the sheet registration device. From the above described tracking procedure, the processor 40 can estimate the arrival of the sheet S at the detector unit 30, so that the detector unit 30 may start generating data D before the passage of the leading edge over said detector unit 30. Using the sheet edge detection device 20 according to the present invention aids in momentarily obtaining a highly accurate position of the sheet edge. By positioning the detector unit 30 closely upstream of e.g. the print heads 9, the detected sheet edge position can be used to accurately print an image on the sheet S at the desired position. Similarly, the sheet S can re-oriented with great accuracy at the sheet registration. In consequence, the print quality is improved.

[0056] In step ii, a sheet arrives at the detector unit 30 and the passage of its trailing or leading over the detector 31 results in a change in the intensity sensed by the detector 31 is detected. During this passage of the sheet edge along the detector 31, the emission level or intensity of the emitter 32 is substantially constant. In consequence, the detector 31 generates signal data D, comprising information describing the change in intensity over time. Preferably, the signal data D comprises vectors of detected intensities and their corresponding detection times, allowing the signal data D to be represented as two dimensional curve D. The signal curve D is generally step shaped.

[0057] A first set of the signal data D is, in step iv, applied to determine the first and second signal levels L1, L2, corresponding respectively to the intensities when no sheet S was present over the detector 31 and when the detector 31 was fully covered by a sheet S. The first and second signal levels L1, L2 may e.g. be determined from respectively the maximum and minimum intensities L1, L2 of the signal data D. In step v, the signal threshold T is derived from the signal levels L1, L2, for example positioned midway between the signal levels L1, L2. The determined signal threshold T can then be used to determine the sheet edge position.

[0058] A finite amount of time is required for the computation of the signal threshold T, such that the signal data D cannot be compared to it when this signal data D is first generated. The present invention provides a delayed signal data D, which is generated such that it can be compared to the determined signal threshold T. This can be done by a second detector unit of the detector assembly, which second detector is positioned downstream of the first detector unit 30, which unit 30 generated the initial data signal D. Thus step iii is basically repeated using a second detector unit.

[0059] It is however preferred to delay a copy or second set of the signal data D generated by the first detector unit 30. No downstream detector unit is then required. The second set of the signal data D is delayed by e.g. temporarily stored it on a storage medium, or, in the case of an analogue signal, delaying the signal D via a delaying circuit, as are commonly applied in signal electronics. The delay enables the second set of signal data D to be available for comparison to the signal threshold T upon completion of the latter's determination. It will be appreciated that the delaying step vi may be performed in parallel with the steps iv and/or v.

[0060] In step vii, the delayed second set of the signal data D is compared to the determined signal threshold T, which, in step viii, yields the sheet edge position of the sensed point on the sheet edge. As explained, the detection time DT corresponding to the intersection X between the second set of signal data D and the threshold T may be determined, from which detection time DT, the sheet edge position may be derived.

[0061] The sheet edge detection device 20 comprises two or more detector units 30 at the upstream end of the calibration transport path section CS. The detector units 30 are laterally spaced apart to sense two separate points on the leading or trailing edge of the sheet S. Steps i to viii are then performed for in parallel for both detector units 30, thereby determining the position of the point on the sheet edge. From the positions of the two points, the processor determines the skewing or orientation of the sheet S. In case the determined skew angle exceeds a predetermined skewing threshold, the processor 40 in step ix controls the registering device 50 to register or rotate the sheet S to correct or eliminate the detected skewing. The sheet S is then registered, such that the image can be printed on the sheet S in step x. The printed

image is then aligned with the sheet edge, without reducing the productivity of the printing system 1.

[0062] Detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. In particular, features presented and described in separate dependent claims may be applied in combination and any advantageous combination of such claims are herewith disclosed.

Further, it is contemplated that structural elements may be generated by application of three-dimensional (3D) printing techniques. Therefore, any reference to a structural element is intended to encompass any computer executable instructions that instruct a computer to generate such a structural element by three-dimensional printing techniques or similar computer controlled manufacturing techniques. Furthermore, such a reference to a structural element encompasses a computer readable medium carrying such computer executable instructions. Further, the terms and phrases used herein are not intended to be limiting; but rather, to provide an understandable description of the invention. The terms "a" or "an", as used herein, are defined as one or more than one. The term plurality, as used herein, is defined as two or more than two. The term another, as used herein, is defined as at least a second or more. The terms including and/or having, as used herein, are defined as comprising (i.e., open language). The term coupled, as used herein, is defined as connected, although not necessarily directly.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. A sheet edge detection device (20) for a printing system (1), comprising:

- a transport path (P) for transporting a sheet (S) to an image forming unit (9) of the printing system (1), which transport path (P) comprises a calibration transport path section (CS) and arranged for transporting sensed sheets to the image forming unit during a calibration of the sheet edge detection device;
- a detector assembly comprising at least one detector unit (30) positioned upstream of the cal-

ibration transport path section (CS), which at least one detector unit (30) comprises an emitter (32) and a detector (31) positioned on opposite sides of the transport path (P), wherein at least one detector unit (30) is arranged to generate signal data defining a signal data curve (D) as a sheet (S) passes the at least one detector unit (30);

- a processor (40) configured for:

- receiving signal data from the detector assembly;
- calibrating a signal threshold (T) by:

- deriving a first signal level (L1) from the signal data (D) corresponding to a state wherein no sheet (S) is present between one of the at least one detector unit (30);

- deriving a second signal level (L2) from the signal data (D) corresponding to a state wherein a sheet (S) covers the detector (31) of at least one detector unit (30), as seen in an emission direction (E) from the emitter (32) to the detector (31);

- comparing the first signal level (L1) and the second signal level (L2) to determine the signal threshold (T);

- comparing a signal data curve (D) received from the detector assembly to the determined signal threshold (T) to determine an intersection (X) between said signal data curve (D) and said signal threshold (T);

- determining a position of a point on a sheet edge of the sheet (S) as said sheet (S) moves over the calibration transport section (CS) from the intersection (X).

2. The sheet edge detection device (20) according to claim 1, further comprising a memory unit (41) for temporarily storing the signal data (D), such that the processor (40) is configured for comparing the stored signal data (D) to the determined signal threshold (T) while the sensed sheet (S) moves over the calibration transport path (CS).

3. The sheet edge detection device (20) according to claim 1, wherein the detector assembly comprises an upstream detector unit (30) positioned upstream of the calibration transport path (CS) and a downstream detector unit (30) positioned along the calibration transport path downstream of the upstream detector unit (30), wherein the processor (40) is configured for:

- comparing the first signal level (L1) and the second signal level (L2) from the upstream detector unit (30) to determine the signal threshold (T); and

- determining a position of a point on a sheet edge of the sheet (S) as said sheet (S) moves over the calibration transport section (CS) by comparing the signal data (D) received from the downstream detector unit (30) to the signal threshold (T) determined from the signal data (D) from the upstream detector unit (30).

4. The sheet edge detection device (20) according to any of the previous claims, further comprising a transport mechanism for uninterrupted transport of the sheet (S) along and from the at least one detector unit (30) to an upstream end of the calibration transport path section (CS) while the processor (40) determines the position of the point on the sheet edge.

5. The sheet edge detection device (20) according to any of the previous claims, wherein the detector (31) of the at least one detector unit (30) is configured to generate a signal curve (D) as a sheet edge passes the detector (31), and wherein the processor (40) is arranged for:

- deriving a first signal level (L1) from the signal curve (D) corresponding to a state wherein no sheet (S) is present between the at least one detector unit (30);

- deriving a second signal level (L2) from the signal curve (D) corresponding to a state wherein the detector (31) of the at least one detector unit (30) is covered by a sheet (S);

- comparing the first signal level (L1) and the second signal level (L2) to determine a signal threshold (T) in between said signal levels (L1, L2); and

- determining the position of the sheet edge from a position of an intersection (X) between said signal curve (D) and the determined threshold (T) relative to said signal curve (D).

6. The sheet edge detection device (20) according to any of the previous claims, wherein the detector assembly comprises a first and a second detector unit (30) laterally spaced apart from one another, each detector unit (30) comprising an emitter (32) and a detector (31) positioned on opposite sides of the transport path (P), and wherein the processor is configured for:

- determining a first position of a first point on the sheet edge of the sheet (S) from first signal data (D) from the first detector unit (30);

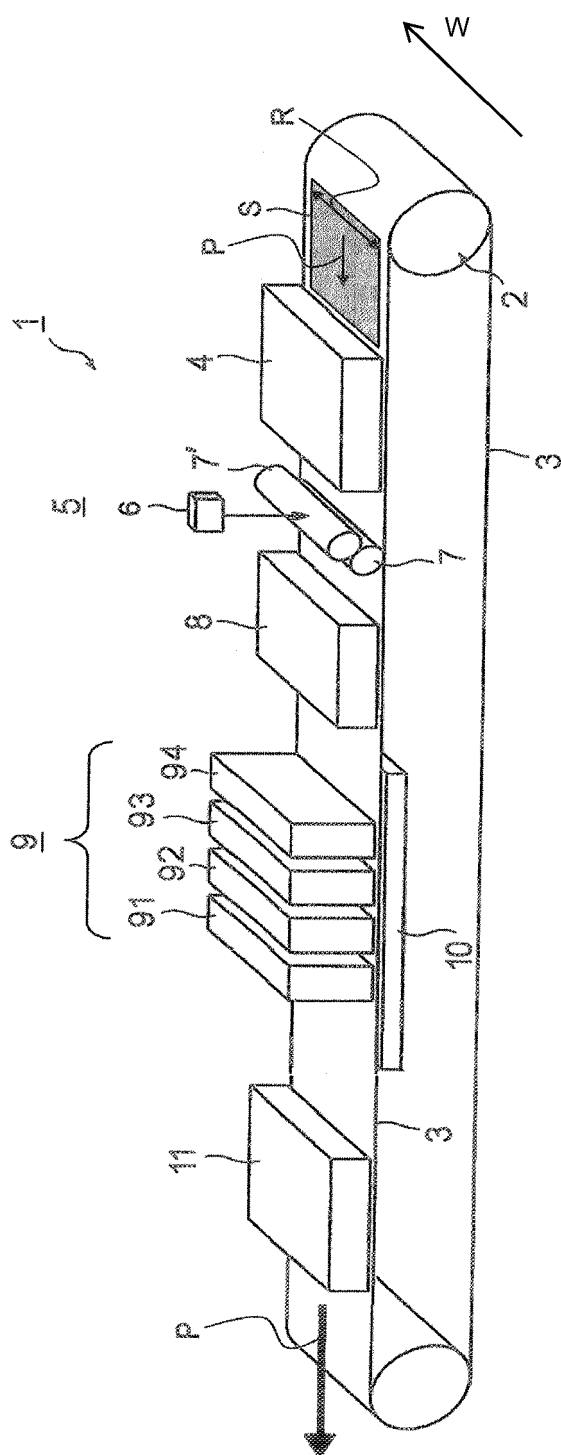
- determining a second position of a second point on the sheet edge of the sheet (S) from

- second signal data (D) from the second detector unit (30);
 - determining an orientation of the sheet edge by comparing the first and second positions to one another. 5
7. The sheet edge detection device (20) according to any of the previous claims, further comprising a registering device (50) positioned downstream of the calibration transport path section (CS), which registering device (50) is configured to re-orientate the sheet edge in correspondence to the determined position of the sheet edge. 10
8. The sheet edge detection device (20) according to claim 6 and 7, wherein the processor (40) is arranged to control the registering device (40) to re-orientate the sheet edge in correspondence to the determined orientation of the sheet edge. 15
9. The sheet edge detection device (20) according to any of the previous claims, wherein the calibration transport path section (CS) has a length in a transport direction (A), which length allows the processor (40) to determine the position of the sheet edge before the sheet edge reaches an upstream end of the calibration transport path (CS). 20
10. The sheet edge detection device (20) according to any of the previous claims, wherein the emitter (32) of the at least one detector unit (30) is configured to emit an emission signal at a predetermined emission intensity level, at least while the at least one detector unit (30) of the detector assembly generates the signal data (D). 25
11. The sheet edge detection device (20) according to any of the previous claims, wherein the at least one detection unit (30) comprises an optical emitter (32) which emits an optical beam signal beam in the emission direction (E) to the detector (31), which is an optical detector (31). 30
12. The sheet edge detection device (20) according to claim 10 or 11, wherein the first signal level (L1) comprises a top intensity level (L1) and the second signal level (L2) comprises a bottom intensity level (L2) derived from the intensity signal data (D), such that the signal threshold (T) is an intensity threshold (T) selected to lie in between the top and bottom intensity levels (L1, L2). 35
13. The sheet edge detection device (20) according to claim 12, wherein the intensity threshold (T) is selected to lie substantially midway between the top and bottom intensity levels (L1, L2). 40
14. Printing system (1), comprising a sheet edge detec-

tion device (20) according to any of the previous claims, wherein the calibration transport path section (CS) is positioned upstream of an image forming unit (9) of the printing system (1).

15. Method of determining the position of a point on a sheet edge of a sheet (S) moving through a printing system (1), the method comprising the steps of:

- transporting a sheet (S) to an image forming unit (9) of the printing system (1);
- transporting the sheet (S) in between an emitter (32) and detector (31) of at least one detector unit (30) for generating signal data (D) defining a signal curve (D); and while said sheet (S) is being transported to the image forming unit (9):
- deriving a first signal level (L1) from the signal data (D) corresponding to a state wherein no sheet (S) is present between emitter (32) and the detector (31) of the at least one detector unit (30);
- sensing a second signal level (L2) from the signal data (D) corresponding to a state wherein a sheet (S) covers the at least one detector unit (30), as seen an emission direction (E) from the emitter (32) to the detector (31);
- comparing the first signal level (L1) and the second signal level (L2) to one another determine a signal threshold (T); and
- comparing a delayed signal curve (D) from at least one detector unit (30) to the determined signal threshold (T) to determine an intersection (X) between said signal curve (D) and said signal threshold (T);
- determining the position of a point on a sheet edge of the sheet (S) from the determined intersection (X).



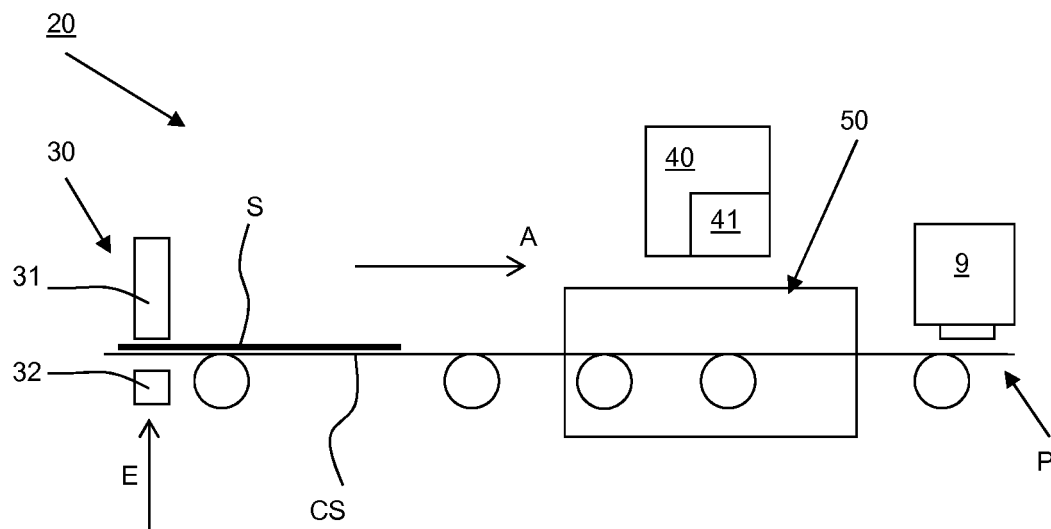


Fig. 2

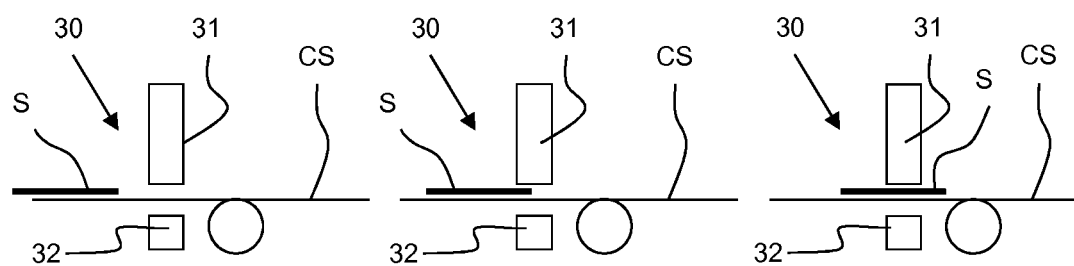


Fig. 3A

Fig. 3B

Fig. 3C

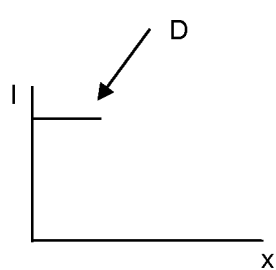


Fig. 4A

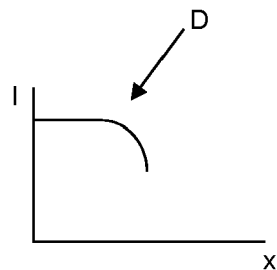


Fig. 4B

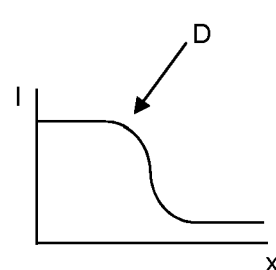
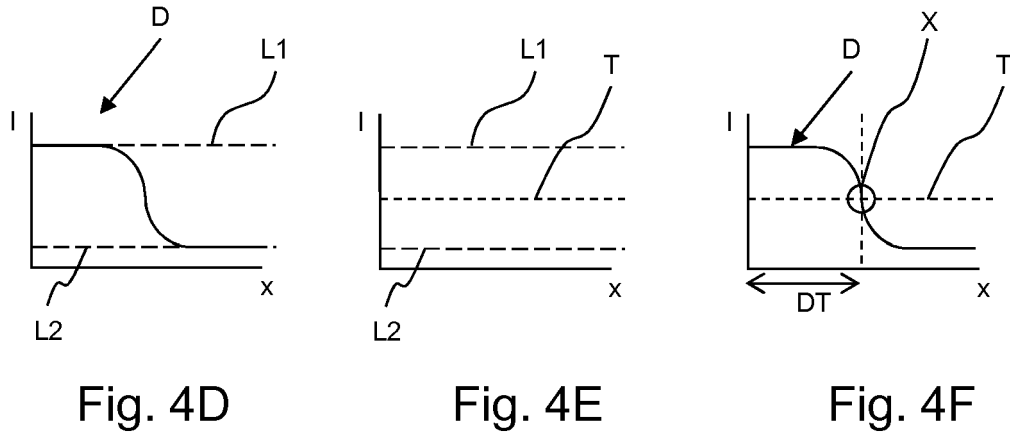
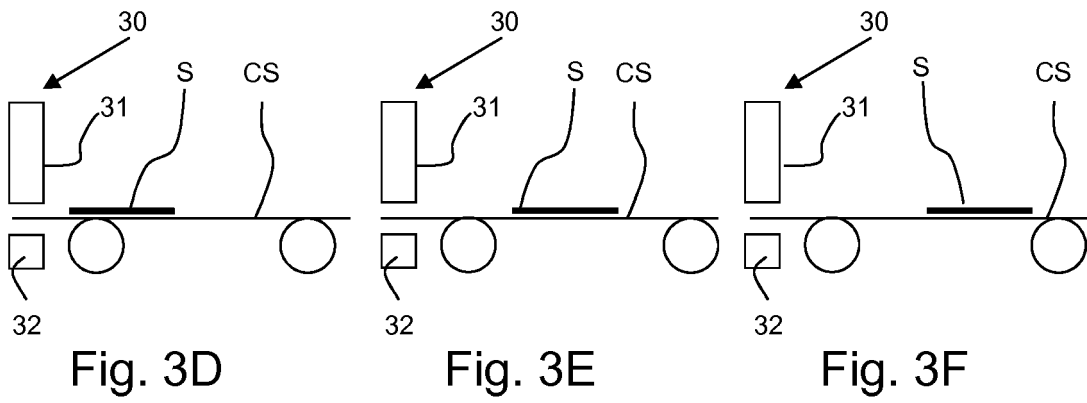


Fig. 4C



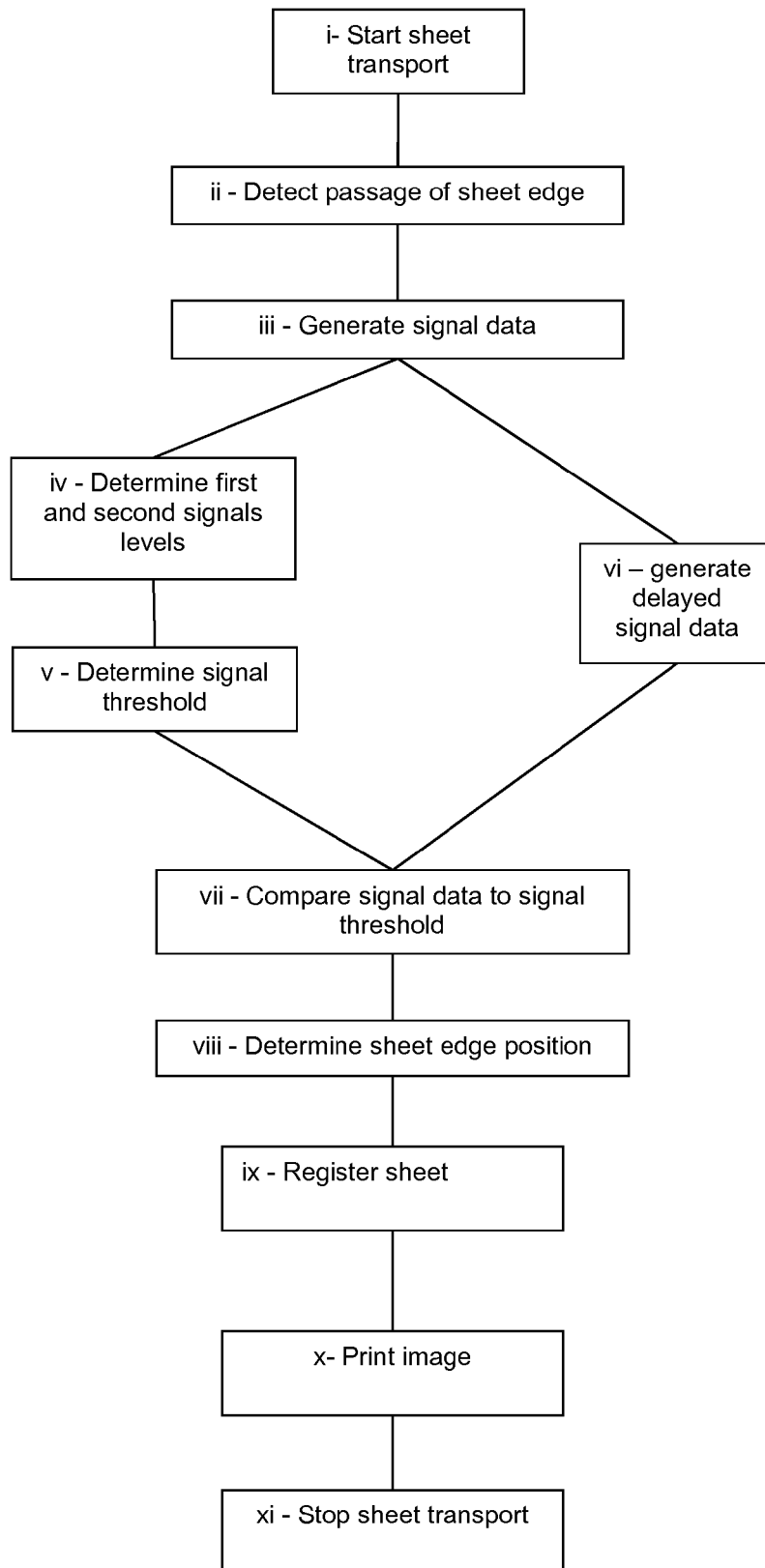


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 18 16 1203

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 27 July 2018	Examiner Gaubinger, Bernhard
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