



(51) International Patent Classification:
G06T 7/00 (2006.01)

(21) International Application Number:
PCT/EP2011/057719

(22) International Filing Date:
12 May 2011 (12.05.2011)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicants (for all designated States except US):
CENTRE DE VISIÓ PER COMPUTADOR (CVC) [ES/ES]; Edifici O, Campus UAB, E-08193 Bellaterra (ES). **UNIVERSITAT AUTÒNOMA DE BARCELONA** [ES/ES]; Area d'investigació. Rectorat, Edifici A - Campus universitari s/n, E-08193 Bellaterra (ES).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **ROCA MARVÀ, Francesc Xavier** [ES/ES]; C. Bilbao, 46-50, esc B, 5º 3ª, E-08005 Barcelona (ES). **GONZÁLEZ SABATÉ, Jordi**

[ES/ES]; C. Alcanyis, 36, 3º A, E-43500 Tortosa (ES). **VIÑAS REDREJO, Miguel Angel** [ES/ES]; C. Guipúscoa, 73, 2º 1ª, E-08227 Terrassa (ES). **SÁNCHEZ MAYORAL, Silvia** [ES/ES]; C. Lleó XIII, 36, bxs. 3ª, E-08222 Terrassa (ES).

(74) Agent: **BARLOCCI, A.**; ZBM Patents- Zea, Barlocchi & Markvardsen, Pl. Catalunya, 1, E-08002 Barcelona (ES).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH,

[Continued on next page]

(54) Title: METHOD FOR DETECTING DEFECTS ON YARNS

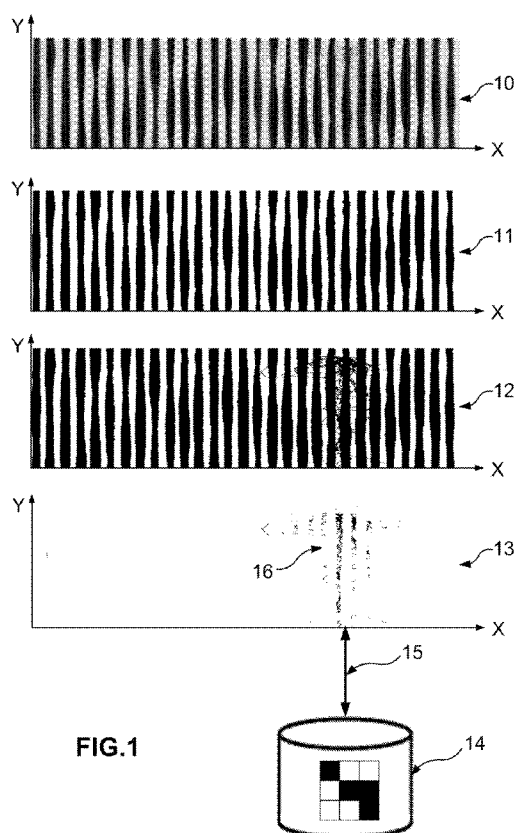


FIG.1

(57) Abstract: In a first aspect, the present invention provides a method for detecting defects on yarns arranged substantially in parallel from a grey scale image (10) of the yarns, said grey scale image being divided into one or more image sections; the method comprising for each image section (10): calculating a restrictive threshold and a less restrictive threshold from the image section (10); obtaining a restrictive image section (11) by applying the restrictive threshold to the image section (10); obtaining a less restrictive image section (12) by applying the less restrictive threshold to the image section (10). Said method further comprises: obtaining a differential image (13) from the obtained restrictive image sections (11) and the obtained less restrictive image sections (12); and detecting defects on the yarns by comparing (15) the pixels (16) of the differential image (13) representing existence of difference with predetermined defect patterns (14).



GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

— *with international search report (Art. 21(3))*

METHOD FOR DETECTING DEFECTS ON YARNS

The present invention relates to a method for detecting defects on yarns arranged substantially in parallel from a grey scale image of the yarns, said
5 grey scale image being represented through a two-dimensional structure of original pixels and said grey scale image being divided into one or more image sections. The invention also refers to a system and a computer program product suitable for carrying out said method.

10 BACKGROUND ART

Methods, computer programs and systems dedicated to yarns inspection for detecting defects on the yarns may be aimed at ensuring good quality of fabrics produced from said yarns.

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Different methods and related computer programs and systems having the objective of ensuring good quality of fabrics are known in the state of the art, some of them dedicated to inspect already produced fabrics. For example, US5301129A discloses a video web inspection system employing filtering and
20 thresholding to determine surface anomalies. Nevertheless, said kind of methods have the drawback of being focused to detect defects on the fabric once the fabric has already been produced, in which case defects of the fabric with origin in defective yarns are detected very late with the consequent waste of time and money.

25

There are other types of methods which are exclusively aimed at inspecting multiple yarns in parallel to each other. For instance, US2010157301A1 discloses a running yarn line inspection method that inspects yarn lines running in parallel in the same surface. In this case, it is possible to anticipate
30 possible defects on fabrics with origin in defective yarns in a not final stage of the fabric manufacturing process, which implies higher reliability and saving of time and money in comparison with the methods discussed in the previous

paragraph.

However, the method described in US2010157301A1 has the limitation of not being reliable enough, since said method is based on the application of a predetermined threshold which may be set on the basis of the difference between the lightness of a normal portion and the lightness of a defect speck obtained by measuring the normal portion and the defect speck prepared by an ideal model or obtained by actual sampling. Then, the method uses said set in advance threshold in a way that when the quantity of a lightness change or the number of pixels of a dark portion showing each yarn width is larger or smaller than the threshold value, it is determined that the yarn concerned has a defect.

With this respect, it has to be taken into account that the light conditions between different executions of the method may vary depending on, for example, the state of a corresponding light source causing the lightness measured by the method. For instance, any kind of lamp normally suffers a continuous degradation along its lifetime and said degradation may surely produce a slight variation of the light conditions between different executions of the method. Thus, the application of such a pre-fixed threshold in a context of variable light conditions may produce not reliable results.

Moreover, when high quantities of yarns are processed under the method of US2010157301A1, the light conditions and, thus, the caused lightness may also vary in the same execution between different regions of the plane in which the multiple yarns run in parallel to each other. Therefore, the application of such a pre-fixed threshold in said context of light conditions variability may cause further reduction of reliability in the results of the method.

SUMMARY OF THE INVENTION

There thus still exists a need for solving at least some of the above mentioned drawbacks. The object of the present invention is to fulfil such a need. Said object is achieved with a method according to claim 1, a computer program product according to claim 14, and a system according to claim 17.

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In a first aspect, the present invention provides a method that comprises calculating, for each image section of the grey scale image, a restrictive threshold from the image section, and obtaining, for each image section and its related restrictive threshold, a restrictive image section by applying the
10 restrictive threshold to the image section. Said restrictive image section is represented through a structure of restrictive pixels identical to the structure of original pixels of the image section, wherein each restrictive pixel represents presence/absence of yarn material according to its related original pixel having a grey level less/greater than the restrictive threshold.

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The method further comprises calculating, for each image section of the grey scale image, a less restrictive threshold from the image section, and obtaining, for each image section and its related less restrictive threshold, a less restrictive image section by applying the less restrictive threshold to the image
20 section. Said less restrictive image section is represented through a structure of less restrictive pixels identical to the structure of original pixels of the image section, wherein each less restrictive pixel represents presence/absence of yarn material according to its related original pixel having a grey level less/greater than the less restrictive threshold.

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Then, once all the restrictive image sections and all the less restrictive image sections have been obtained, a differential image is obtained from said obtained restrictive image sections and said obtained less restrictive image sections. Said differential image is represented through a structure of
30 differential pixels identical to the structure of original pixels of the grey scale image, wherein each differential pixel represents existence/absence of difference between each pair of related restrictive and less restrictive pixels.

Particularly, each pair of related restrictive and less restrictive pixels wherein the restrictive pixel represents absence of yarn material and the related less restrictive pixel represents existence of yarn material, may result in a related differential pixel representing existence of difference. The inverse situation may be also possible, that is to say, each pair of related restrictive and less restrictive pixels wherein the restrictive pixel represents existence of yarn material and the related less restrictive pixel represents absence of yarn material, may result in a related differential pixel representing existence of difference. Moreover, each pair of related restrictive and less restrictive pixels wherein both the restrictive pixel and its related less restrictive pixel represents the same situation (presence or absence of yarn material), may result in a related differential pixel representing absence of difference.

Once the differential image has been obtained, the differential pixels of said differential image representing existence of difference are compared with predetermined defect patterns for detecting defects on the yarns.

This method has the advantage of compensating any variation of the light conditions under which different grey scale images may have been obtained for their processing through different executions of the method. This advantage is consequence of the restrictive threshold and the less restrictive threshold being obtained dynamically in each execution and directly related to each image section under process in said execution. In other words, different grey scale images taken under different light conditions are associated with different thresholds depending on said different light conditions, which permit to reduce the probabilities of erroneous results derived from said variability and, therefore, making this method more reliable.

Moreover, this method takes into account that the grey scale image may comprise one or more sections. The combination of this feature and the previously commented calculation of restrictive and less restrictive thresholds

from each of said sections allow attenuating the impact of different light conditions under which the grey scale image may have been taken. Particularly, taking an image of a high number of parallel yarns surely implies not uniform light conditions along the entire theoretic plane made up by the parallel yarns. For example, it is very difficult to ensure that central and peripheral regions of said theoretic plane have the same light conditions when taking an image of the yarns, in which case considering several sections of the image and obtaining the related thresholds from each of said sections allow increasing the reliability of the method in relation to, for example, calculating and applying only one restrictive and one less restrictive threshold related to the entire grey scale image.

Furthermore, the method is based on the idea of each restrictive image section representing only the main body of the yarns (without possible deviated fibers) and each less restrictive image section representing the main body and the fibers potentially deviated from the main body. Thus, the way of obtaining the differential image from the restrictive image sections and the less restrictive image sections permits selecting only the possible deviated fibers, so that, from this point of the method, all the actions are concentrated to detect defects from only the differential pixels representing possible deviated fibers, which improves efficiency of the method.

Additionally, the comparison of said differential pixels representing possible deviated fibers with predetermined defect patterns gives to the method a very high flexibility, since said patterns may be predefined according to different criteria, as for example, depending on the type of yarns to be inspected, and/or depending on the light conditions under which the grey scale image has been taken, and/or any other condition with possible impact on the method and its reliability, efficacy, efficiency, etc.

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In a second aspect of the present invention, it is provided a computer program product comprising program instructions for causing a computer to perform

said method for detecting defects on yarns. The invention also relates to such a computer program product embodied on a storage medium (for example, a CD-ROM, a DVD, a USB drive, on a computer memory or on a read-only memory) or carried on a carrier signal (for example, on an electrical or optical carrier signal).

In a third aspect, the present invention provides a system for detecting defects on yarns arranged substantially in parallel from a grey scale image of the yarns, said grey scale image being represented through a two-dimensional structure of original pixels and said grey scale image being divided into one or more image sections. The system comprises computing means for calculating, for each image section of the grey scale image, a restrictive threshold from the image section; and computing means for obtaining, for each image section and its related restrictive threshold, a restrictive image section by applying the restrictive threshold to the image section. Said restrictive image section is represented through a structure of restrictive pixels identical to the structure of original pixels of the image section, wherein each restrictive pixel represents presence/absence of yarn material according to its related original pixel having a grey level less/greater than the restrictive threshold.

The system further comprises computing means for calculating, for each image section of the grey scale image, a less restrictive threshold from the image section; and computing means for obtaining, for each image section and its related less restrictive threshold, a less restrictive image section by applying the less restrictive threshold to the image section. Said less restrictive image section is represented through a structure of less restrictive pixels identical to the structure of original pixels of the image section, wherein each less restrictive pixel represents presence/absence of yarn material according to its related original pixel having a grey level less/greater than the less restrictive threshold.

The system further comprises computing means for obtaining, once all the

restrictive image sections and all the less restrictive image sections have been generated, a differential image from said restrictive image sections and said less restrictive image sections. Said differential image is represented through a structure of differential pixels identical to the structure of original pixels of the
5 grey scale image, wherein each differential pixel represents existence/absence of difference between each pair of related restrictive and less restrictive pixels.

The system further comprises computing means for comparing, once the
10 differential image has been obtained, the differential pixels of the differential image representing existence of difference with predetermined defect patterns for detecting defects on the yarns.

Throughout the description and claims the word "comprise" and variations of
15 the word, are not intended to exclude other technical features, additives, components, or steps. Additional objects, advantages and features of the invention will become apparent to those skilled in the art upon examination of the description or may be learned by practice of the invention. The following examples and drawings are provided by way of illustration, and they are not
20 intended to be limiting of the present invention. Reference signs related to drawings and placed in parentheses in a claim, are solely for attempting to increase the intelligibility of the claim, and shall not be construed as limiting the scope of the claim. Furthermore, the present invention covers all possible combinations of particular and preferred embodiments described herein.

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BRIEF DESCRIPTION OF THE DRAWINGS

Particular embodiments of the present invention will be described in the following by way of non-limiting examples, with reference to the appended
30 drawings, in which:

Figure 1 is a schematic representation of a method for detecting defects on

yarns arranged substantially in parallel from a grey scale image of the yarns, according to an embodiment of the invention;

Figure 2 is a schematic representation of calculating a restrictive threshold and a less restrictive threshold, according to an embodiment of the invention;

5 Figure 3 is a schematic representation of packing a restrictive image section or a less restrictive image section, according to an embodiment of the invention;

Figure 4 is a schematic representation of expanding width of yarns in a restrictive image section, according to an embodiment of the invention;

10 Figure 5 is a schematic representation of comparing differential pixels representing existence of difference with predetermined defect patterns, according to an embodiment of the invention;

Figure 6 is a schematic representation of comparing differential pixels representing existence of difference with predetermined defect patterns
15 oriented to detect horizontal sequences of contiguous differential pixels representing existence of difference, according to an embodiment of the invention;

Figure 7 is a schematic representation of detecting defects from vertical accumulations of differential pixels representing existence of difference,
20 according to an embodiment of the invention;

Figure 8 is a schematic representation of detecting defects from horizontal accumulations of differential pixels representing existence of difference, according to an embodiment of the invention;

Figure 9 is a schematic representation of detecting defects from problematic
25 inter-yarn sections, according to an embodiment of the invention; and

Figure 10 is a schematic representation of a lateral view and a frontal view of a system for detecting defects on a plurality of yarns running substantially in parallel, according to an embodiment of the invention.

30 DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

In the following descriptions, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be understood, however, by one skilled in the art, that the present invention may be practiced without some or all of these specific details. In other instances, well known elements have not been described in detail in order not to unnecessarily obscure the description of the present invention.

Figure 10 schematically shows a lateral view 10a and a frontal view 10b of a system for detecting defects on a plurality of yarns 1003 running substantially in parallel, according to an embodiment of the invention. Said system comprises an image capturing device 1001 (e.g. a lineal camera) connected 1002 to a computer system 1000. This computer system 1000 comprises means for storing and executing a computer program suitable for carrying out an embodiment of a method for detecting defects on a plurality of yarns 1003 running substantially in parallel, said method comprising an embodiment of the method for detecting defects on yarns 1003 arranged substantially in parallel from a grey scale image of the yarns 1003.

The operation of the camera 1001 is under control of the computer program in a way that a grey scale image of the yarns 1003 is taken within a frequency, and said image is processed by the computer program for detecting defects on the yarns 1003 as will be explained in later descriptions. Said frequency may be set in advance in accordance with the configuration of the mechanism causing the yarns 1003 to run in parallel, as for example minimum and/or maximum speed. In other embodiments, said mechanism may comprise sensor elements being in charge of dynamically detecting the speed of the yarns 1003 and transmitting it to the computer system for its evaluation and dynamic determination of the frequency. In this case, the frequency may vary along the time, since it depends on the speed of the yarns 1003 which, of course, may be variable. In other embodiments, the mechanism causing the yarns 1003 to run may comprise an encoder sending to the computer 1000 a number of pulses for each number of millimetres that the running yarns 1003

have covered. Then, an image line may be captured for each received pulse, so that the grey scale image of the yarns 1003 may be obtained from a predetermined number (e.g. 512) of said captured lines. In this case, the frequency may also vary along the time.

5

The system of Figure 10 also comprises lighting means 1004 (e.g. a fluorescent) arranged just under the theoretical plane made up by the parallel yarns, said lighting means generating the necessary light conditions for ensuring that each obtained grey scale image represents yarn material and background in a way that the yarn material may be distinguished from the background as better as possible taking into account the grey level of each pixel of the grey scale image. However, it has to be considered that when processing a medium/big amount of yarns it is very difficult, maybe impossible, to ensure maximum uniformity of light conditions.

15

Then, each grey scale image obtained through the image capturing means 1001 may be divided into a plurality of image sections according to predetermined splitting parameters, with the objective of attenuating possible negative effects of a not uniform lighting conditions along the entire theoretical plane made up by the parallel yarns 1003. Once the grey scale image has been divided into said sections, the computer program proceeds to detect defects on the yarns 1003 by executing the computer vision actions that will be detailed in following descriptions.

20

Figure 1 graphically represents the main conceptual principles of an embodiment of the method for detecting defects on yarns arranged substantially in parallel from a grey scale image 10 of the yarns. Said grey scale image may be obtained through the image capturing device 1001, and may be represented through a two-dimensional (X,Y) structure of original pixels, and may be divided into one or more image sections, as commented before.

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In the embodiment conceptually represented through Figure 1, the method comprises, for each image section 10 of the grey scale image, calculating a restrictive threshold and a less restrictive threshold from the image section 10. After that, a restrictive image section 11 is generated by applying the restrictive threshold to the image section 10, and a less restrictive image section 12 is generated by applying the less restrictive threshold to the image section 10. Said restrictive image section 11 may be represented through a structure of restrictive pixels identical to the structure of original pixels of the image section 10, wherein each restrictive pixel represents presence/absence of yarn material according to its related original pixel having a grey level less/greater than the restrictive threshold. And said less restrictive image section 12 may be represented through a structure of less restrictive pixels identical to the structure of original pixels of the image section 10, wherein each less restrictive pixel represents presence/absence of yarn material according to its related original pixel having a grey level less/greater than the less restrictive threshold.

This way of obtaining the restrictive and the less restrictive image sections respond to the idea of selecting on the restrictive image sections only the pixels representing the main body of the yarns (without possible deviated fibers), and selecting on the less restrictive image sections the main body of the yarns and the possible deviated fibers. Then, said restrictive and less restrictive image sections are used to generate a differential image 13, which is represented through a structure of differential pixels identical to the structure of original pixels of the grey scale image 10, wherein each differential pixel 16 represents existence/absence of difference between each pair of related restrictive and less restrictive pixels.

Particularly, each pair of related restrictive and less restrictive pixels wherein the restrictive pixel represents absence of yarn material and the related less restrictive pixel represents existence of yarn material, may result in a related differential pixel representing existence of difference. The inverse situation

may be also possible, that is to say, each pair of related restrictive and less restrictive pixels wherein the restrictive pixel represents existence of yarn material and the related less restrictive pixel represents absence of yarn material, may result in a related differential pixel representing existence of difference. Moreover, each pair of related restrictive and less restrictive pixels wherein both the restrictive pixel and its related less restrictive pixel represents the same situation (presence or absence of yarn material), may result in a related differential pixel representing absence of difference. Thus, in the context of the idea related to yarns body and deviated fibers, it may be interpreted that the obtained differential pixels representing existence of difference refers to only deviated fibers which are candidates to be part of a defect.

In the Figure 1, the grey scale image 10 only comprises one image section 10 for simplicity and best understanding reasons, but it is considered that any skilled (even not skilled) person will be able to expand this mono-section approach to a multi-section approach in a very simple and direct manner taking into account the descriptions referred to Figure 1.

Once the differential image 13 has been obtained, this embodiment of the method comprises comparing the differential pixels 16 representing existence of difference with predetermined defect patterns 14 in order to detect any possible defect on the yarns 1003.

Figure 2 graphically shows the main concepts and logics of calculating the restrictive threshold 207 and the less restrictive threshold 206 from the image section 10, according to an embodiment based on the Otsu's method. Firstly, it is calculated a histogram 200 of the image section 10 representing for each grey level 203 the number of pixels 202 having said grey level 203, said calculation of the histogram 200 producing a bimodal histogram 200 comprising a relative peak 210 most representative of presence of yarn

material and a relative peak 211 most representative of absence of yarn material.

Once the bimodal histogram 200 has been generated, it is determined a first
5 grey level 204 corresponding to the relative peak 210 most representative of
presence of yarn material, and a second grey level 205 corresponding to the
relative peak 211 most representative of absence of yarn material. Then, the
restrictive threshold 207 is calculated by selecting an intermediate grey level
207 between the first grey level 204 and the second grey level 205, and the
10 less restrictive threshold 206 is calculated by applying a predetermined
percentage 208 to the difference 201 between the second grey level 205 and
the first grey level 204.

Figure 3 refers to a small region 300 of a grey scale image section 10 and its
15 related region 301 in the restrictive 11 or less restrictive 12 image section
associated with said grey scale image section 10. This Figure shows the main
concepts and principles of packing the restrictive sections 11, which
comprises converting each restrictive pixel 309,310 into a binary digit 311,312,
one of the possible values 311 (e.g. '0') of said binary digit representing
20 presence of yarn material and the other possible value 312 (e.g. '1') of said
binary digit representing absence of yarn material. Equivalently, the less
restrictive image sections 12 may be packed by converting each less
restrictive pixel 309,310 into a binary digit 311,312, one of the possible values
311 (e.g. '0') of said binary digit representing presence of yarn material and
25 the other possible value 312 (e.g. '1') of said binary digit representing absence
of yarn material.

This manner of packing both the restrictive 11 and the less restrictive 12
image sections permits to highly reduce the necessary memory to store said
30 sections and the necessary processing resources to undertake any of the later
algorithms on said sections. For instance, the differential image 12 may be

generated through very simple logic operations (e.g. AND, XOR, etc.) applied to the restrictive 11 and the less restrictive 12 image sections.

5 In some embodiments of the method with reference to Figure 4, the two-dimensional X,Y structure of original pixels comprises an horizontal dimension X and a vertical dimension Y according to a two-dimensional Cartesian coordinate system X,Y, each value of the horizontal dimension X identifying a column of original pixels and each value of the vertical dimension Y identifying a row of original pixels. Furthermore, the longitudinal axis 411 of each yarn
10 represented in the grey scale image is substantially parallel to the axis of the Cartesian coordinate system X,Y corresponding to the vertical dimension Y.

Figure 4 conceptually represents a way of expanding the width of the resulting bodies of the yarns in the restrictive image sections 11, according to an
15 embodiment of the invention. The previously explained way of obtaining the restrictive image sections 11 based on its related restrictive threshold 207, apart from eliminating pixels representing deviated fibers, may cause elimination of peripheral pixels of the body of the yarns representing existence of yarn material. This possible bad consequence may be attenuated by forcing
20 said expansion of the width of the bodies of the yarns as will be described below.

This expansion may be achieved by detecting, for each row 401 of restrictive pixels, pairs 404 of contiguous restrictive pixels in which one 405 of said
25 contiguous restrictive pixels represents presence of yarn material and the other 406 contiguous restrictive pixel represents absence of yarn material. Then, for each detected pair 404 of contiguous restrictive pixels, it is converted 410 the contiguous restrictive pixel 406 representing absence of yarn material into 407 representing presence of yarn material. These actions
30 generate expansion of the yarns bodies in one pixel per side of the body, but said actions may be repeated a determined number of times depending on, for example, the type of the yarns to be inspected.

Said logic based on detecting pairs 404 of contiguous restrictive pixels in which one 405 of said contiguous restrictive pixels represents presence of yarn material and the other 406 contiguous restrictive pixel represents absence of yarn material, may also be applied to calculate the number of yarns represented in a specific grey scale image with the objective of verifying if said calculated number of yarns has changed in relation to previously processed grey scale images. Then, if a change in the number of yarns is detected, it may be concluded that a fatal error has been produced, in which case an alarm signal indicating that the image number of yarns has changed may be generated.

More specifically, still with reference to Figure 4, the method for detecting defects on yarns arranged substantially in parallel from a grey scale image may further comprise, for each obtained restrictive image section 11, calculating a section number of yarns of the restrictive image section 11 from at least three of the rows 401 of restrictive pixels of the restrictive image section 11, taking into account the corresponding detected pairs 404 of contiguous restrictive pixels in which one 405 of said contiguous restrictive pixels represents presence of yarn material and the other 406 contiguous restrictive pixel represents absence of yarn material. After that, the calculated section numbers of yarns may be added for obtaining an image number of yarns, which may be compared with other image numbers of yarns of previously processed grey scale images in order to detect a change in this respect, in which case an alarm signal indicating that the image number of yarns has changed may be generated.

In some embodiments, calculating a section number of yarns of the restrictive image section (11) from at least three of the rows (401) of restrictive pixels of the restrictive image section (11), may comprise calculating a row number of yarns for each of said at least three rows (401) of restrictive pixels of the restrictive image section (11), taking into account the corresponding detected

pairs (404) of contiguous restrictive pixels in which one (405) of said contiguous restrictive pixels represents presence of yarn material and the other (406) contiguous restrictive pixel represents absence of yarn material. Then, the value that occurs most frequently in the set of calculated row numbers of yarns may be selected as the section number of yarns of the restrictive image section (11).

In embodiments of the invention, verifying if the calculated image number of yarns has changed in relation to previously obtained grey scale images of the yarns may comprise taking into account a predetermined number of previously obtained grey scale images of the yarns, and ignoring some punctual change in the number of yarns and, thus, considering that the number of yarns has not changed. For instance, if the predetermined number of previously obtained grey scale images is five and said five images has a number of yarns N, whereas only the image in process has a number of yarns M, this punctual change may be considered a momentary union of yarns which not necessarily implies a defect to be reported. However, if, for example, the first three previous images have a number of yarns N, but the last two previous images and the image in process have a number of yarns M, this situation may be considered a defect to be reported, so the result of the verification will be positive result.

Figure 5 graphically illustrates the comparison of differential pixels representing existence of difference with predetermined defect patterns, according to an embodiment of the invention. Said way of comparison comprises, for each differential pixel representing existence of difference, obtaining a differential neighbourhood comprising differential pixels contiguous to said differential pixel representing existence of difference. Then, in case of the differential neighbourhood not matching any of the predetermined defect patterns, the differential pixel is converted into representing inexistence of difference. After that, the remaining differential pixels representing existence of difference are marked

as detected defects.

In the particular example of Figure 5, the values of the differential pixels 500-507 make up a binary number 511 ('10001001' in the example) taking into account that the pixel 507 has the higher weight ('7' in the example) and the pixel 500 has the lower weight ('0' in the example). This binary number 511 whose decimal representation 512 is '137' may be used for accessing to the corresponding position ('137') of a look-up-table 14 indicating if the configuration of pixels 500-507 matches 15 or not a defect pattern. In case of not matching, the differential pixel 514 is converted into representing inexistence of difference. In case of matching, the differential pixel 514 remains as representing existence of difference.

Figure 6 refers to that the predetermined defect patterns 14 may be oriented to detect horizontal sequences 600 of contiguous differential pixels representing existence of difference, according to an embodiment of the invention.

Under the premise of the predetermined defect patterns 14 being oriented to detect horizontal sequences 600 of contiguous differential pixels representing existence of difference, the Figure 7 refers to an embodiment in which marking as detected defects the differential pixels representing existence of difference comprises obtaining 721 a vertical accumulation 701 for each column of differential pixels, said vertical accumulation 701 representing the number of differential pixels of the column representing existence of difference. Once said vertical accumulations 701 have been generated, a columns window 705 covering a predetermined number 713 of columns of differential pixels and related vertical accumulations 701 is defined.

After that, a sequence of horizontal X positions 716-718 of the columns window 705 is determined in a way that each vertical accumulation 701 is covered by the columns window 705 in at least one of said horizontal X

positions 716-718 and each horizontal X position 716-718 and its next horizontal X position in the sequence of horizontal X positions 716-718 are separated by a predetermined number of columns of differential pixels. For example, said sequence of horizontal X positions may comprise an initial
5 position 716, a final position 717 and a plurality of intermediate positions 718.

For instance, a first intermediate position may be obtained by adding the predetermined number of columns to the initial position 716, a second intermediate position may be obtained by adding the predetermined number of
10 columns to the first intermediate position, a third intermediate position may be obtained by adding the predetermined number of columns to the second intermediate position, and so on, until the final position 717 is reached. The predetermined number of columns may be one or more columns, but taking into account that the maximum reliability will be ensured by setting said
15 predetermined number of columns to one column.

In case of, for example, defining a columns window 705 covering eleven columns the initial position 716 may be coded with the number six ($11=5+1+5$), that is to say the central column of the columns window 705 in
20 said initial position 716. Another option would be to code said initial position 716 with the pair of numbers one and eleven, that is to say the initial column (one) and the final column (eleven) of the columns window 705 in said initial position 716.

25 Once the sequence of horizontal X positions 716-718 of the columns window 705 has been determined, a columns window accumulation 702 is obtained 722 for each determined horizontal X position 718 of the columns window 705, said columns window accumulation 702 being obtained by accumulating the vertical accumulations 701 covered by the columns window 705 in said
30 determined horizontal X position 718.

After that, problematic columns 719 are determined by selecting each column

of differential pixels corresponding to a horizontal X position 718 of the columns window 705 having a columns window accumulation 702 exceeding a columns window threshold 703. Then, only the differential pixels of the determined problematic columns 719 representing existence of difference may
5 be marked as detected defects.

This defects detection approach graphically represented through the Figure 7 increases the reliability of the method, since the concept of columns window 705 permits evaluate, in each horizontal position of said columns window 705,
10 a set of proximal columns 713 and their related vertical accumulations 701, so that the columns window accumulation 702 generated for said columns window 705 in said horizontal position constitutes a good indicator of the level of accumulation of pixels representing existence of difference within said set of proximal columns 713. A high level of accumulation will probably determine
15 some defect.

Figure 8 refers to concepts and logics very similar to the concepts and logics supported by Figure 7. The main difference is that Figure 7 refers to vertical accumulations 701 and columns window accumulations 702 for determination
20 of problematic columns 719 whereas Figure 8 refers to horizontal accumulations 801 and rows window accumulations 802 within said determined problematic columns 719. Said horizontal scanning within the problematic columns 719 adds even more reliability to the method, since a double evaluation (vertical and horizontal) of differential pixels representing
25 existence of difference is undertaken, so the possibilities of detecting real defects are increased.

Particularly, Figure 8 refers to an embodiment in which marking as detected defects the differential pixels of the determined problematic columns 719
30 representing existence of difference comprises, for each concentration of problematic columns 719, obtaining 821 a horizontal accumulation 801 for each row of differential pixels in said concentration of problematic columns

719, defining a rows window 805 covering a predetermined number 813 of rows of differential pixels and related horizontal accumulations 801 in said concentration of problematic columns 719, determining a sequence of vertical Y positions 816-818 of the rows window 805 in said concentration of problematic columns 719, obtaining a rows window accumulation 802 for each determined vertical Y position 817 of the rows window 805 in said concentration of problematic columns 719, verifying if at least one of the obtained rows window accumulations 802 exceeds a rows window threshold 803 in said concentration of problematic columns 719, and, in case of positive result of said verification, marking as detected defects the differential pixels of said concentration of problematic columns 719 representing existence of difference.

In relation to the abovementioned generation 821 of a horizontal accumulation 801 for each row of differential pixels in said concentration of problematic columns 719, said horizontal accumulation 801 represents the number of differential pixels of the row representing existence of difference.

In reference to the previously mentioned determination of a sequence of vertical Y positions 816-818 of the rows window 805 in said concentration of problematic columns 719, said determination is undertaken in a way that each horizontal accumulation 801 is covered by the rows window 805 in at least one of said determined vertical Y positions 816-818 and each vertical Y position 816-818 and its next vertical Y position in the sequence of vertical Y positions 816-818 are separated by a predetermined number of rows of differential pixels. For example, said sequence of vertical Y positions may comprise an initial position 816, a final position 817 and a plurality of intermediate positions 818.

For instance, a first intermediate position may be obtained by adding the predetermined number of rows to the initial position 816, a second intermediate position may be obtained by adding the predetermined number of

rows to the first intermediate position, a third intermediate position may be obtained by adding the predetermined number of rows to the second intermediate position, and so on, until the final position 817 is reached. The predetermined number of rows may be one or more rows, but taking into
5 account that the maximum reliability will be ensured by setting said predetermined number of rows to one row.

In case of, for example, defining a rows window 805 covering eleven rows the initial position 816 may be coded with the number six ($11=5+1+5$), that is to
10 say the central row of the rows window 805 in said initial position 816. Another option would be to code said initial position 816 with the pair of numbers one and eleven, that is to say the initial row (one) and the final row (eleven) of the rows window 805 in said initial position 816.

15 In relation to the calculation 822 of a rows window accumulation 802 for each determined vertical Y position 817 of the rows window 805 in said concentration of problematic columns 719, said rows window accumulation 802 is obtained by accumulating the horizontal accumulations 801 covered by the rows window 805 in said determined vertical Y position 817 of the rows
20 window 805.

Once the rows window accumulations 802 have been calculated in said concentration of problematic columns 719, it is verified if at least one of the obtained rows window accumulations 802 exceeds a rows window threshold
25 803. Then, in case of positive result of said verification, the differential pixels of said concentration of problematic columns 719 representing existence of difference are marked as detected defects.

Figure 9 refers to an embodiment in which marking as detected defects the
30 differential pixels of said concentration of problematic columns 719 representing existence of difference comprises: determining problematic inter-yarn sections 902 from vertical accumulations 701 greater than a

predetermined vertical accumulation threshold 903 in said concentration of problematic columns 719, calculating the number of determined problematic inter-yarn sections 902, and verifying if said calculated number of determined problematic inter-yarn sections 902 exceeds a predetermined minimum
5 number of problematic inter-yarn sections. Then, in case of positive result of said verification, the differential pixels of said problematic inter-yarn sections 902 representing existence of difference are marked as detected defects.

Still with the support of Figure 9, marking as detected defects the differential
10 pixels of said problematic inter-yarn sections 902 representing existence of difference may comprise: detecting concentrations of adjacent problematic inter-yarn sections 902, and for each of said concentrations of adjacent problematic inter-yarn sections 902: calculating the number of adjacent problematic inter-yarn sections 902 in said concentration of adjacent
15 problematic inter-yarn sections 902, verifying if said calculated number of adjacent problematic inter-yarn sections 902 exceeds a predetermined minimum number of adjacent problematic inter-yarn sections and, in case of positive result of said verification, marking as detected defects the differential pixels of said concentration of adjacent problematic inter-yarn sections 902
20 representing existence of difference.

The abovementioned detection of concentrations of adjacent problematic inter-yarn sections 902 may be very well understood with the support of Figures 9 and 4, since said detection is carried out by taking into account that
25 two problematic inter-yarn sections 902 are adjacent in case of being separated by only one yarn 901 section, said only one yarn 901 section being determined from the obtained restrictive image sections 11 taking into account, for at least one of the rows 403 of restrictive pixels of each obtained restrictive image section 11, the pairs 413 of contiguous restrictive pixels in
30 which one 407 of said contiguous restrictive pixels represents presence of yarn material and the other 414 contiguous restrictive pixel represents absence of yarn material.

This way of detecting defects by evaluating inter-yarn sections 902 permits a very reliable detection of very damaging defects during, for example, the wrap of yarns which is a previous stage to the final production of the corresponding
5 fabrics.

In other embodiments, the method may further comprise, for each concentration of problematic columns 719 comprising detected defects, calculating a ratio of columns window accumulations 720 exceeding the
10 columns window threshold 703 in said concentration of problematic columns 719 in relation to the columns window threshold 703, calculating a ratio of rows window accumulations 820 exceeding the rows window threshold 803 in said concentration of problematic columns 719 in relation to the rows window threshold 803, calculating a defect ratio from the calculated ratio of columns
15 window accumulations 720 and the calculated ratio of rows window accumulations 820, and converting said calculated defect ratio into a defect category according to a predetermined defect categorization scale.

As illustrated in Figure 7, the line representing all the columns window accumulations 702 and the X axis constitute at least one surface whose area
20 may be calculated and referred as total columns area. In the same way, the line representing all the columns window accumulations 702 exceeding the columns window threshold 703 and the line corresponding to the columns window threshold 703 constitute at least one surface 720 whose area may be
25 calculated and referred as exceeding columns area. The ratio of columns window accumulations 720 exceeding the columns window threshold 703 may be calculated, for example, from said total columns area and said exceeding columns area 720.

30 As illustrated in Figure 8, the line representing all the rows window accumulations 802 and the X axis constitute at least one surface whose area may be calculated and referred as total rows area. In the same way, the line

representing all the rows window accumulations 802 exceeding the rows window threshold 803 and the line corresponding to the rows window threshold 803 constitute at least one surface 820 whose area may be calculated and referred as exceeding rows area. The ratio of rows window accumulations 802 exceeding the rows window threshold 803 may be calculated, for example, from said total rows area and said exceeding rows area 820.

This categorization of the defects may be very useful for the users of the system (and method) being in charge of, for example, a yarns wrap process and its monitoring. The obtained defect categories may be, for example, very good indicators for evaluating quality of yarns suppliers, for reconfiguring the system (and method) by changing some variable parameters, as for example: columns window threshold 703, rows window threshold 803, vertical accumulation threshold 903, etc.

Although this invention has been disclosed in the context of certain preferred embodiments and examples, it will be understood by those skilled in the art that the present invention extends beyond the specifically disclosed embodiments to other alternative embodiments and/or uses of the invention and obvious modifications and equivalents thereof. Thus, it is intended that the scope of the present invention herein disclosed should not be limited by the particular disclosed embodiments described before, but should be determined only by a fair reading of the claims that follow.

25

Further, although the embodiments of the invention described with reference to the drawings comprise computer apparatus and processes performed in computer apparatus, the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of source code, object code, a code intermediate source and object code such as in partially compiled form, or in any other form suitable for use in the implementation of

the processes according to the invention. The carrier may be any entity or device capable of carrying the program.

For example, the carrier may comprise a storage medium, such as a ROM, for
5 example a CD ROM or a semiconductor ROM, or a magnetic recording medium, for example a floppy disc or hard disk. Further, the carrier may be a transmissible carrier such as an electrical or optical signal, which may be conveyed via electrical or optical cable or by radio or other means.

10 When the program is embodied in a signal that may be conveyed directly by a cable or other device or means, the carrier may be constituted by such cable or other device or means.

Alternatively, the carrier may be an integrated circuit in which the program is
15 embedded, the integrated circuit being adapted for performing, or for use in the performance of, the relevant processes.

CLAIMS

1. Method for detecting defects on yarns arranged substantially in parallel from a grey scale image (10) of the yarns, said grey scale image being represented through a two-dimensional (X,Y) structure of original pixels and said grey scale image being divided into one or more image sections; the method comprising:
- for each image section (10) of the grey scale image:
- calculating a restrictive threshold (207) from the image section (10);
 - 10 • obtaining a restrictive image section (11) by applying the restrictive threshold (207) to the image section (10), said restrictive image section (11) being represented through a structure of restrictive pixels identical to the structure of original pixels of the image section (10), wherein each restrictive pixel represents presence/absence of yarn material according to its related original pixel having a grey level less/greater than the restrictive threshold (207);
 - 15 • calculating a less restrictive threshold (206) from the image section (10);
 - obtaining a less restrictive image section (12) by applying the less restrictive threshold (206) to the image section (10), said less restrictive image section (12) being represented through a structure of less restrictive pixels identical to the structure of original pixels of the image section (10), wherein each less restrictive pixel represents presence/absence of yarn material according to its related original pixel having a grey level less/greater than the less restrictive threshold (206);
 - 20 • obtaining a differential image (13) from the obtained restrictive image sections (11) and the obtained less restrictive image sections (12), said differential image (13) being represented through a structure of differential pixels identical to the structure of original pixels of the grey scale image (10), wherein each differential pixel (16) represents existence of difference between each pair of related restrictive and less restrictive pixels;
 - 25 • detecting defects on the yarns by comparing (15) the differential pixels
- 30

(16) representing existence of difference with predetermined defect patterns (14).

2. Method according to claim 1, wherein calculating the restrictive threshold (207) from the image section (10) is based on the Otsu's method, said calculation of the restrictive threshold (207) comprising:

- calculating a histogram (200) of the image section (10) representing for each grey level (203) the number of pixels (202) having said grey level (203), said calculation of the histogram (200) producing a bimodal histogram (200) comprising a relative peak (210) most representative of presence of yarn material and a relative peak (211) most representative of absence of yarn material;
- determining a first grey level (204) corresponding to the relative peak (210) most representative of presence of yarn material;
- determining a second grey level (205) corresponding to the relative peak (211) most representative of absence of yarn material;
- calculating the restrictive threshold (207) by selecting an intermediate grey level (207) between the first grey level (204) and the second grey level (205).

20

3. Method according to claim 2, wherein calculating the less restrictive threshold (206) from the image section (10) comprises:

- calculating the less restrictive threshold (206) by applying a predetermined percentage (208) to the difference (201) between the second grey level (205) and the first grey level (204).

25

4. Method according to any of claims 1 to 3, wherein obtaining the restrictive image section (11) further comprises:

- converting each restrictive pixel (309,310) into a binary digit (311,312), one of the possible values (311) of said binary digit representing presence of yarn material and the other possible value (312) of said binary digit representing absence of yarn material;

30

and wherein obtaining the less restrictive image section (12) further comprises:

- converting each less restrictive pixel (309,310) into a binary digit (311,312), one of the possible values (311) of said binary digit representing presence of yarn material and the other possible value (312) of said binary digit representing absence of yarn material.

5. Method according to any of claims 1 to 4, wherein the two-dimensional (X,Y) structure of original pixels comprises an horizontal dimension (X) and a vertical dimension (Y) according to a two-dimensional Cartesian coordinate system (X,Y), each value of the horizontal dimension (X) identifying a column of original pixels and each value of the vertical dimension (Y) identifying a row of original pixels;

wherein the longitudinal axis (411) of each yarn represented in the grey scale image is substantially parallel to the axis of the Cartesian coordinate system (X,Y) corresponding to the vertical dimension (Y);

and wherein obtaining the restrictive image section (11) further comprises:

repeating a predetermined number of expanding repetitions:

for each row (401) of restrictive pixels of the restrictive image section (11):

- detecting pairs (404) of contiguous restrictive pixels in which one (405) of said contiguous restrictive pixels represents presence of yarn material and the other (406) contiguous restrictive pixel represents absence of yarn material;

for each detected pair (404) of contiguous restrictive pixels:

- converting (410) the contiguous restrictive pixel (406) representing absence of yarn material into (407) representing presence of yarn material.

6. Method according to claim 5, wherein detecting defects on the yarns by comparing (15) the differential pixels (16) representing existence of difference with predetermined defect patterns (14) comprises:

for each differential pixel (514) of the differential image (13) representing existence of difference:

- obtaining a differential neighbourhood (511,512) comprising differential pixels (500-507) contiguous to said differential pixel (514) representing existence of difference;
- in case of the differential neighbourhood (511,512) not matching (15) any of the predetermined defect patterns (14): converting the differential pixel (514) into representing inexistence of difference;
- marking as detected defects the differential pixels representing existence of difference.

7. Method according to claim 6, wherein the predetermined defect patterns (14) are oriented to detect horizontal sequences (600) of contiguous differential pixels representing existence of difference;

and wherein marking as detected defects the differential pixels representing existence of difference comprises:

- obtaining (721) a vertical accumulation (701) for each column of differential pixels, said vertical accumulation (701) representing the number of differential pixels of the column representing existence of difference;
- defining a columns window (705) covering a predetermined number (713) of columns of differential pixels and related vertical accumulations (701);
- determining a sequence of horizontal (X) positions (716-718) of the columns window (705) in a way that each vertical accumulation (701) is covered by the columns window (705) in at least one of said horizontal (X) positions (716-718) and each horizontal (X) position (716-718) and its next horizontal (X) position in the sequence of horizontal (X) positions (716-718) are separated by a predetermined number of columns of differential pixels;
- obtaining (722) a columns window accumulation (702) for each determined horizontal (X) position (718) of the columns window (705), said columns window accumulation (702) being obtained by accumulating the vertical accumulations (701) covered by the columns window (705) in said determined horizontal (X) position (718) of the columns window (705);

- determining problematic columns (719) by selecting each column of differential pixels corresponding to a horizontal (X) position (718) of the columns window (705) having a columns window accumulation (702) that exceeds a columns window threshold (703);

- 5 • marking as detected defects the differential pixels of the determined problematic columns (719) representing existence of difference.

8. Method according to claim 7, wherein marking as detected defects the differential pixels of the determined problematic columns (719) representing
10 existence of difference comprises:

for each concentration of problematic columns (719):

- obtaining (821) a horizontal accumulation (801) for each row of differential pixels in said concentration of problematic columns (719), said horizontal accumulation (801) representing the number of differential pixels
15 of the row representing existence of difference;

- defining a rows window (805) covering a predetermined number (813) of rows of differential pixels and related horizontal accumulations (801) in said concentration of problematic columns (719);

- determining, in said concentration of problematic columns (719), a
20 sequence of vertical (Y) positions (816-818) of the rows window (805) in a way that each horizontal accumulation (801) is covered by the rows window (805) in at least one of said determined vertical (Y) positions (816-818) and each vertical (Y) position (816-818) and its next vertical (Y) position in the sequence of vertical (Y) positions (816-818) are separated by a
25 predetermined number of rows of differential pixels;

- obtaining, in said concentration of problematic columns (719), a rows window accumulation (802) for each determined vertical (Y) position (817) of the rows window (805), said rows window accumulation (802) being obtained by accumulating the horizontal accumulations (801) covered by
30 the rows window (805) in said determined vertical (Y) position (817) of the rows window (805);

- verifying, in said concentration of problematic columns (719), if at

least one of the obtained rows window accumulations (802) exceeds a rows window threshold (803):

in case of positive result:

- marking as detected defects the differential pixels of said concentration of problematic columns (719) representing existence of difference.

9. Method according to claim 8, wherein marking as detected defects the differential pixels of said concentration of problematic columns (719) representing existence of difference comprises:

- determining problematic inter-yarn sections (902) from vertical accumulations (701) greater than a predetermined vertical accumulation threshold (903) in said concentration of problematic columns (719);

- calculating the number of determined problematic inter-yarn sections (902);

- verifying if said calculated number of determined problematic inter-yarn sections (902) exceeds a predetermined minimum number of problematic inter-yarn sections;

in case of positive result:

- marking as detected defects the differential pixels of said problematic inter-yarn sections (902) representing existence of difference.

10. Method according to claim 9, wherein marking as detected defects the differential pixels of said problematic inter-yarn sections (902) representing existence of difference comprises:

- detecting concentrations of adjacent problematic inter-yarn sections (902) taking into account that two problematic inter-yarn sections (902) are adjacent in case of being separated by only one yarn (901) section, said only one yarn (901) section being determined from the obtained restrictive image sections (11) taking into account, for at least one of the rows (403) of restrictive pixels of each obtained restrictive image section (11), the pairs (413) of contiguous restrictive pixels in which one (407) of said contiguous

restrictive pixels represents presence of yarn material and the other (414) contiguous restrictive pixel represents absence of yarn material;

for each concentration of adjacent problematic inter-yarn sections (902):

5 • calculating the number of adjacent problematic inter-yarn sections (902) in said concentration of adjacent problematic inter-yarn sections (902);

 • verifying if said calculated number of adjacent problematic inter-yarn sections (902) exceeds a predetermined minimum number of adjacent problematic inter-yarn sections;

10 in case of positive result:

 • marking as detected defects the differential pixels of said concentration of adjacent problematic inter-yarn sections (902) representing existence of difference.

15 11. Method according to any of claims 8 to 10, further comprising:

 for each concentration of problematic columns (719) comprising detected defects:

20 • calculating a ratio of columns window accumulations (720) exceeding the columns window threshold (703) in said concentration of problematic columns (719) in relation to the columns window threshold (703);

 • calculating a ratio of rows window accumulations (820) exceeding the rows window threshold (803) in said concentration of problematic columns (719) in relation to the rows window threshold (803);

25 • calculating a defect ratio from the calculated ratio of columns window accumulations (720) and the calculated ratio of rows window accumulations (820);

 • converting said calculated defect ratio into a defect category according to a predetermined defect categorization scale.

30 12. Method for detecting defects on a plurality of yarns running substantially in parallel, comprising:

 repeating according to a frequency:

- obtaining a grey scale image of the yarns which are running substantially in parallel;
- dividing the obtained grey scale image into a plurality of image sections according to predetermined splitting parameters;
- 5 • detecting defects on the yarns by applying the method for detecting defects on yarns according to any of claims 1 to 11 to said obtained grey scale image of the yarns divided into said plurality of image sections.

13. Method according to claim 12, when claim 12 depends on any of claims 5
10 to 11, wherein the method further comprises:

for each obtained restrictive image section (11):

- calculating a section number of yarns of the restrictive image section (11) from at least three of the rows (401) of restrictive pixels of the restrictive image section (11), taking into account the corresponding
15 detected pairs (404) of contiguous restrictive pixels in which one (405) of said contiguous restrictive pixels represents presence of yarn material and the other (406) contiguous restrictive pixel represents absence of yarn material;
 - calculating an image number of yarns by adding the calculated section
20 numbers of yarns;
 - verifying if said calculated image number of yarns has changed in relation to previously obtained grey scale images of the yarns;
- in case of positive result: generating an alarm signal indicating that the image number of yarns has changed.

25

14. A computer program product comprising program instructions for causing a computer to perform a method for detecting defects on yarns according to any of claims 1 to 13.

30 15. A computer program product according to claim 14, embodied on a storage medium.

16. A computer program product according to claim 14, carried on a carrier signal.

17. System for detecting defects on yarns arranged substantially in parallel
5 from a grey scale image (10) of the yarns, said grey scale image being represented through a two-dimensional (X,Y) structure of original pixels and said grey scale image being divided into one or more image sections; the method comprising:

- computing means for calculating, for each image section (10) of the grey
10 scale image, a restrictive threshold (207) from the image section (10);

- computing means for obtaining, for each image section (10) and its related restrictive threshold (207), a restrictive image section (11) by applying the restrictive threshold (207) to the image section (10), said restrictive image section (11) being represented through a structure of restrictive pixels identical
15 to the structure of original pixels of the image section (10), wherein each restrictive pixel represents presence/absence of yarn material according to its related original pixel having a grey level less/greater than the restrictive threshold (207);

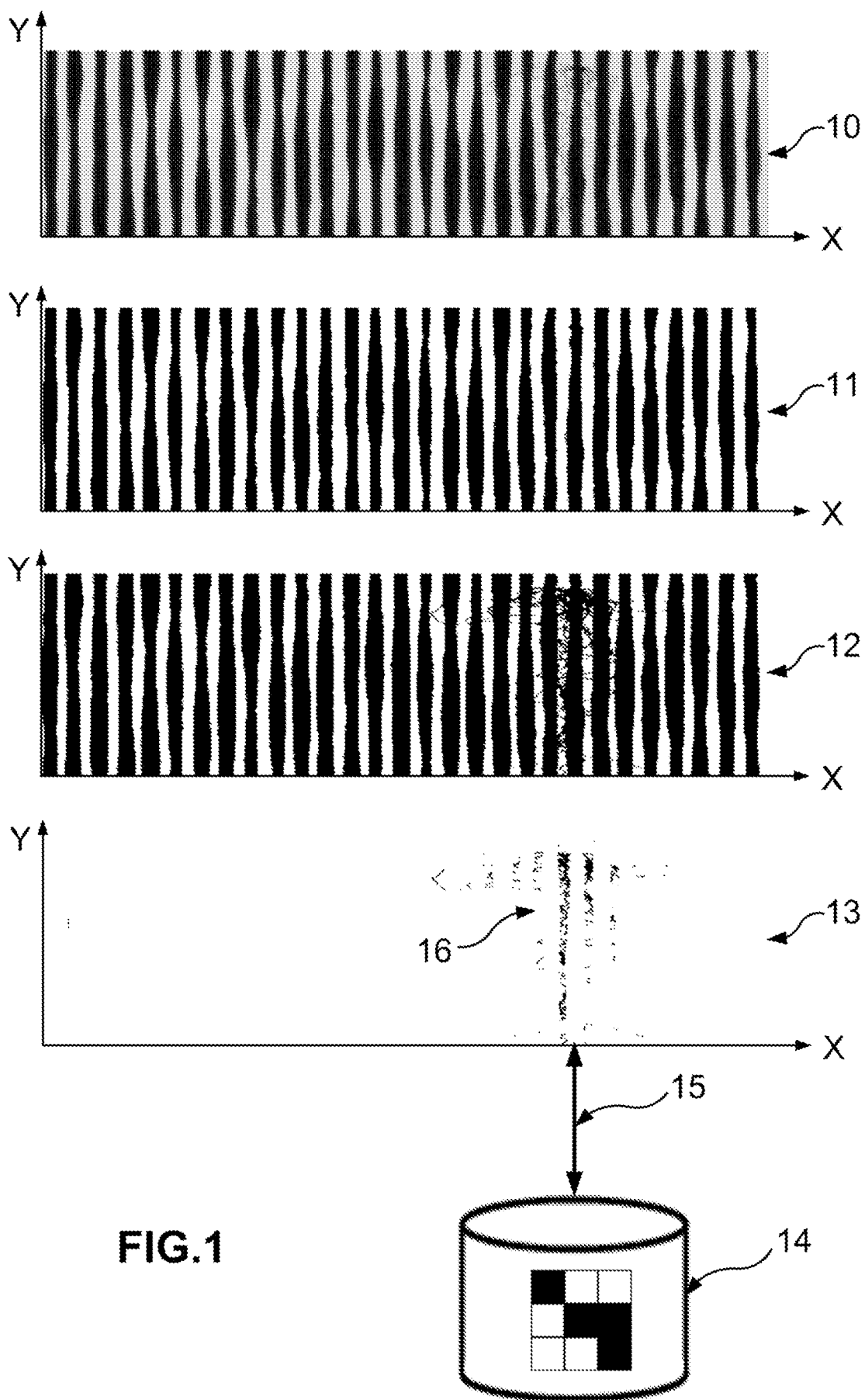
- computing means for calculating, for each image section (10) of the grey
20 scale image, a less restrictive threshold (206) from the image section (10);

- computing means for obtaining, for each image section (10) and its related less restrictive threshold (206), a less restrictive image section (12) by applying the less restrictive threshold (206) to the image section (10), said less restrictive image section (12) being represented through a structure of
25 less restrictive pixels identical to the structure of original pixels of the image section (10), wherein each less restrictive pixel represents presence/absence of yarn material according to its related original pixel having a grey level less/greater than the less restrictive threshold (206);

- computing means for obtaining a differential image (13) from the
30 obtained restrictive image sections (11) and the obtained less restrictive image sections (12), said differential image (13) being represented through a structure of differential pixels identical to the structure of original pixels of the

grey scale image (10), wherein each differential pixel (16) represents existence/absence of difference between each pair of related restrictive and less restrictive pixels;

- computing means for detecting defects on the yarns by comparing (15)
- 5 the differential pixels (16) representing existence of difference with predetermined defect patterns (14).



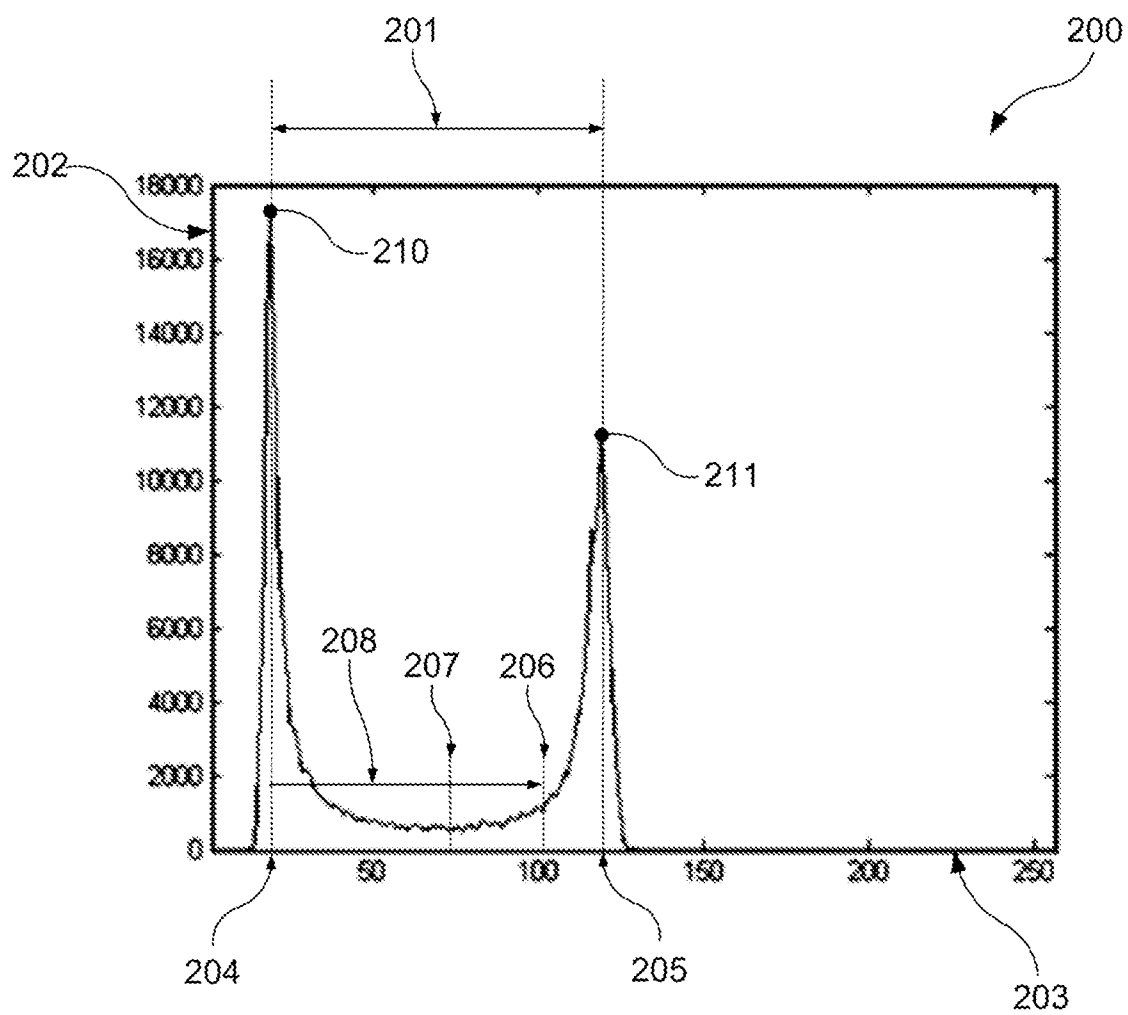
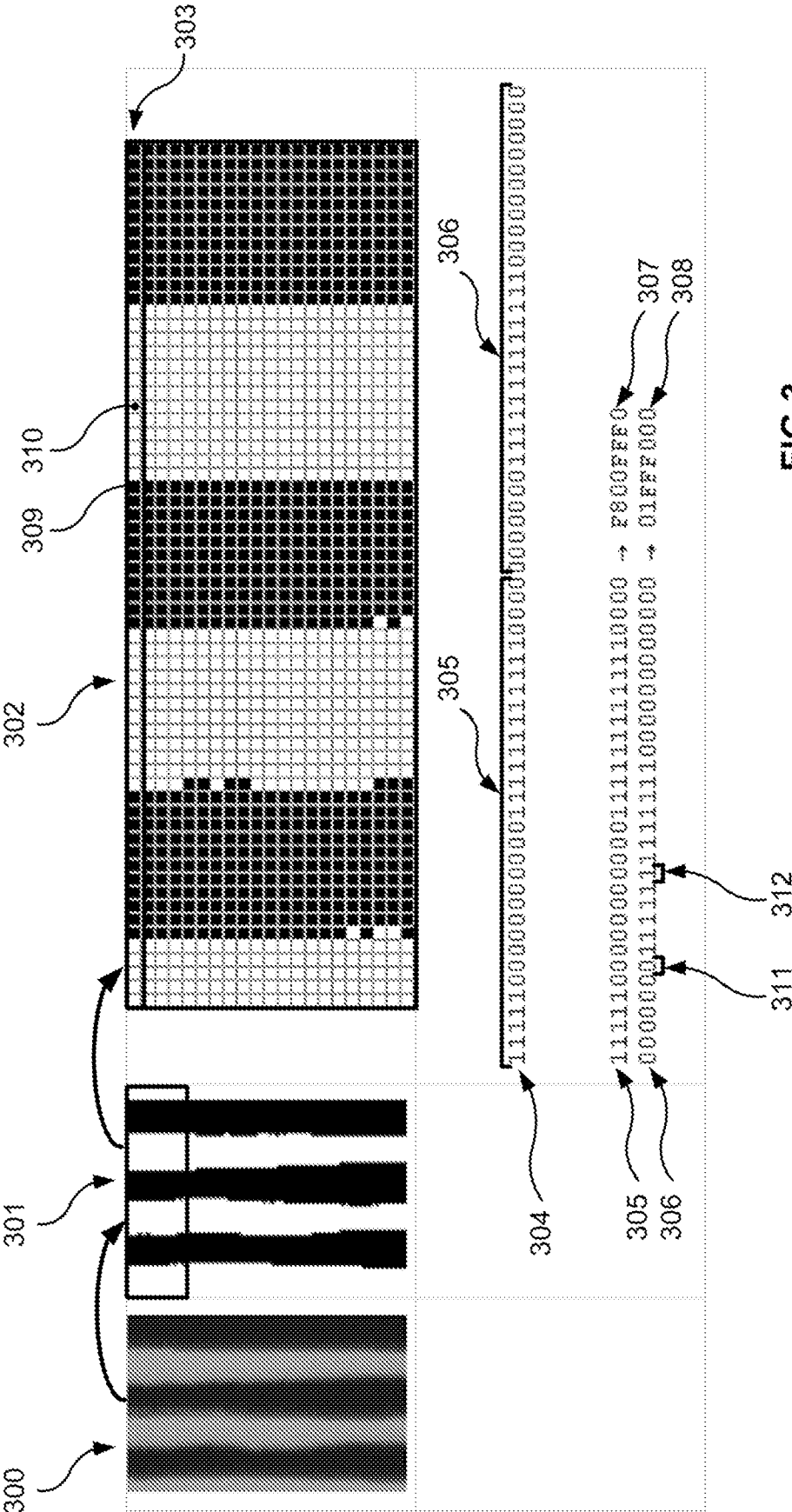


FIG.2



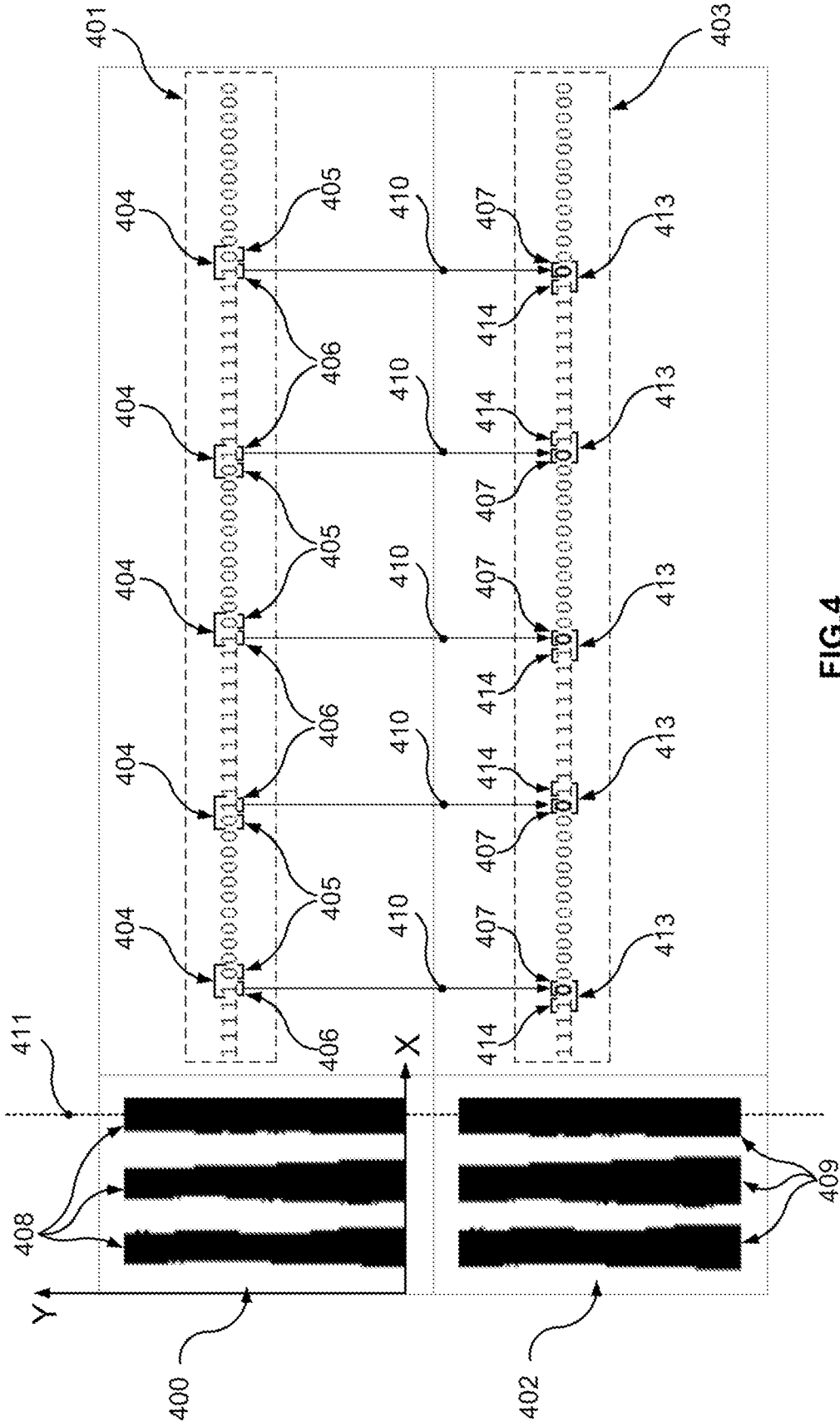


FIG.4

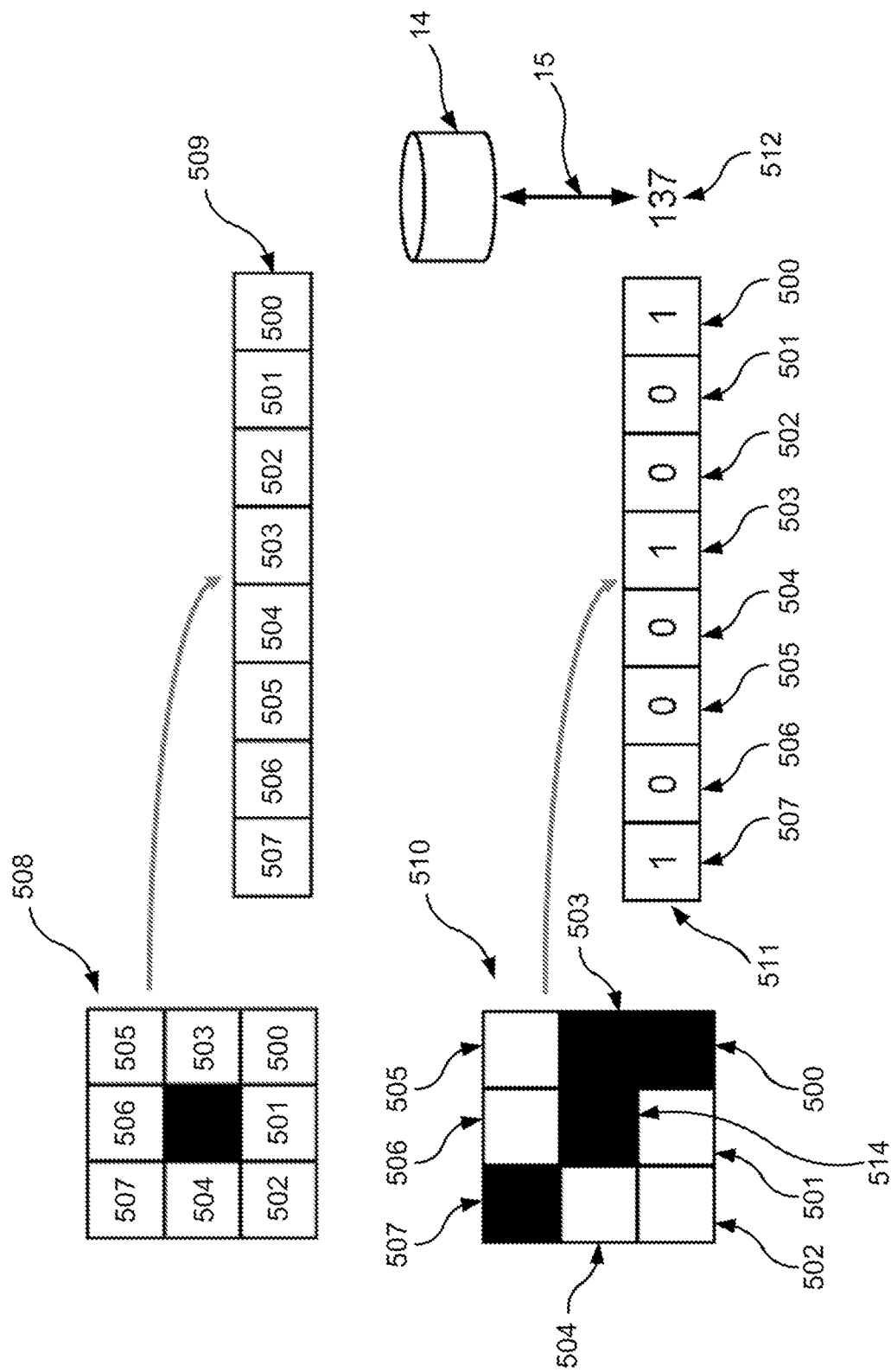


FIG. 5

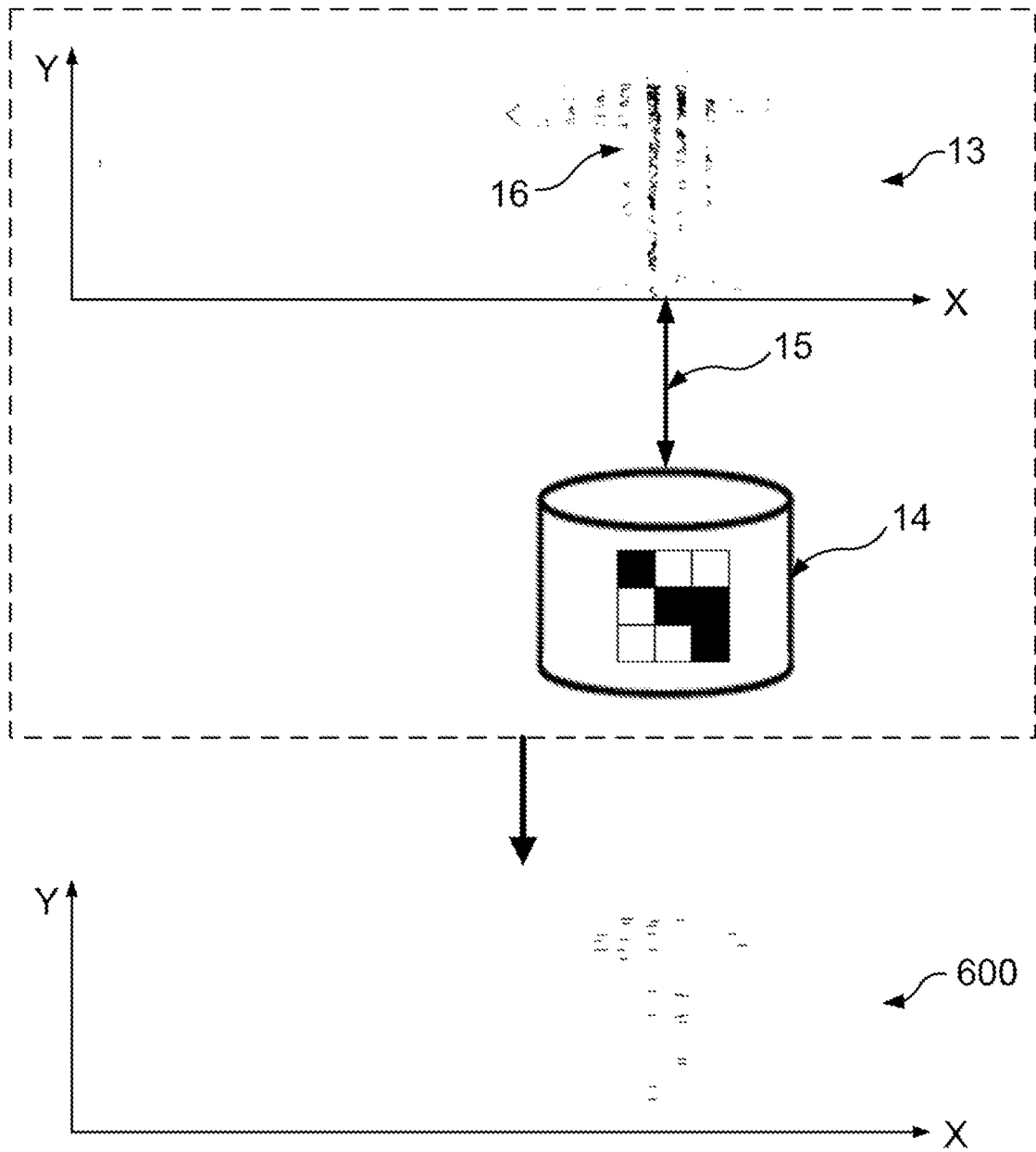


FIG.6

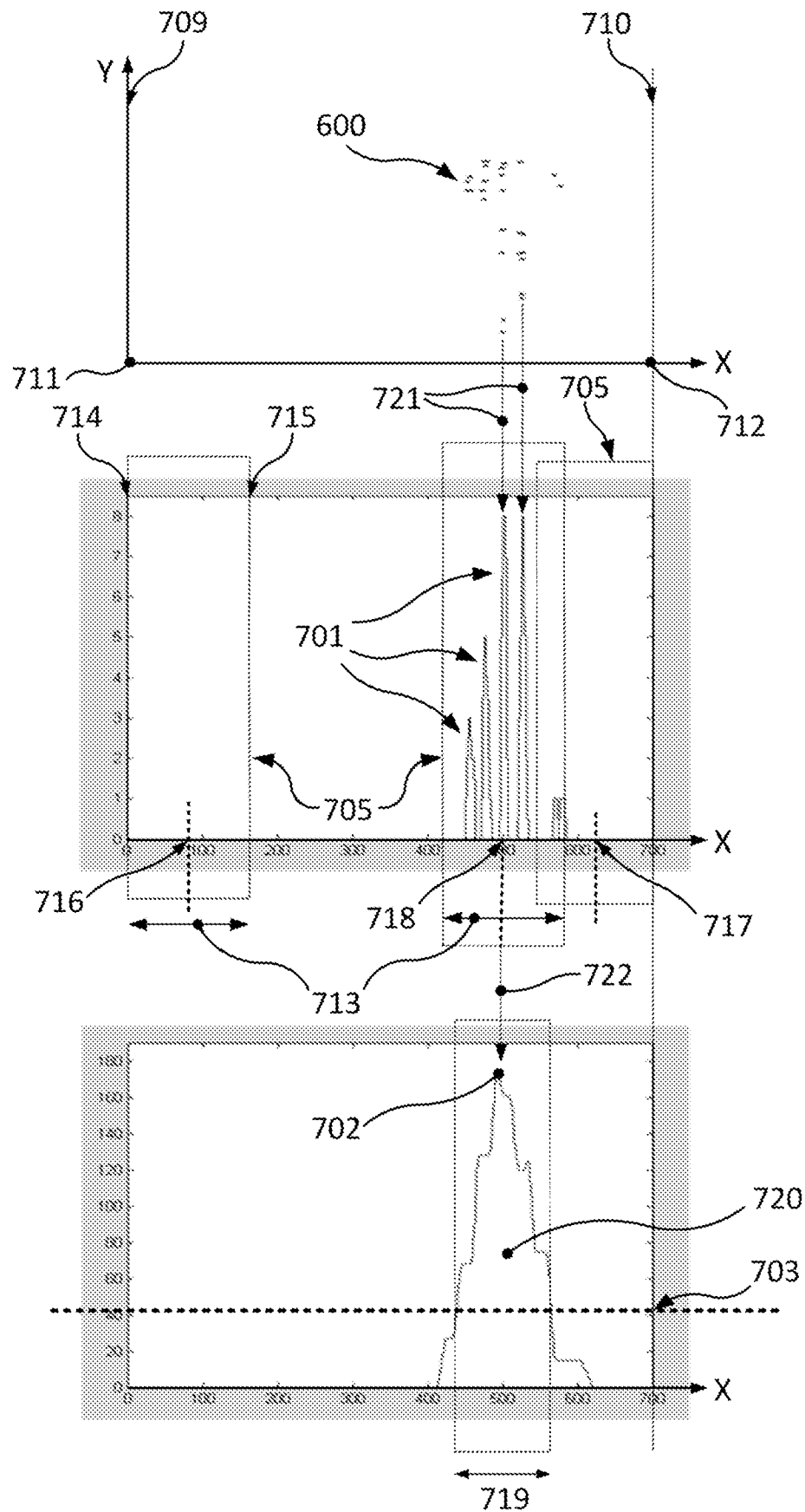


FIG.7

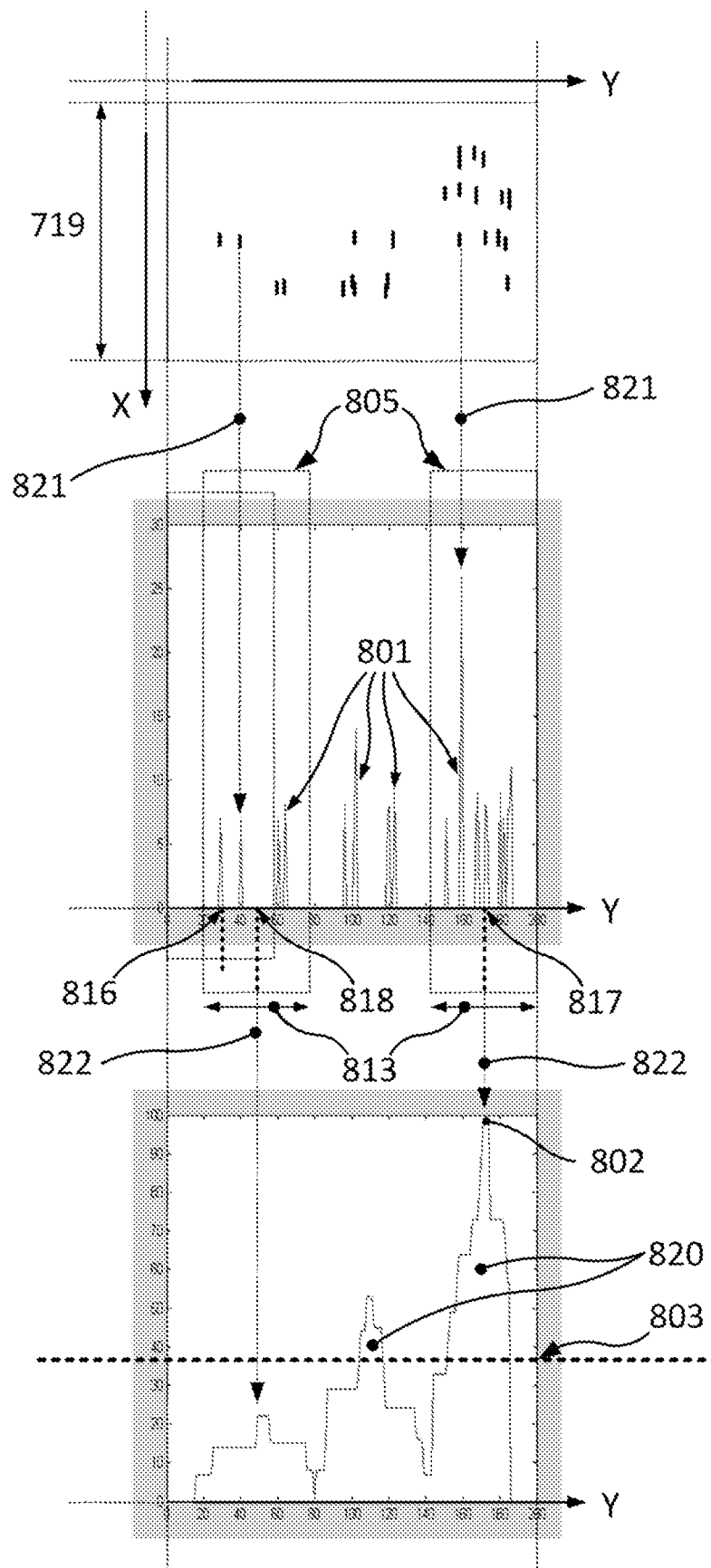
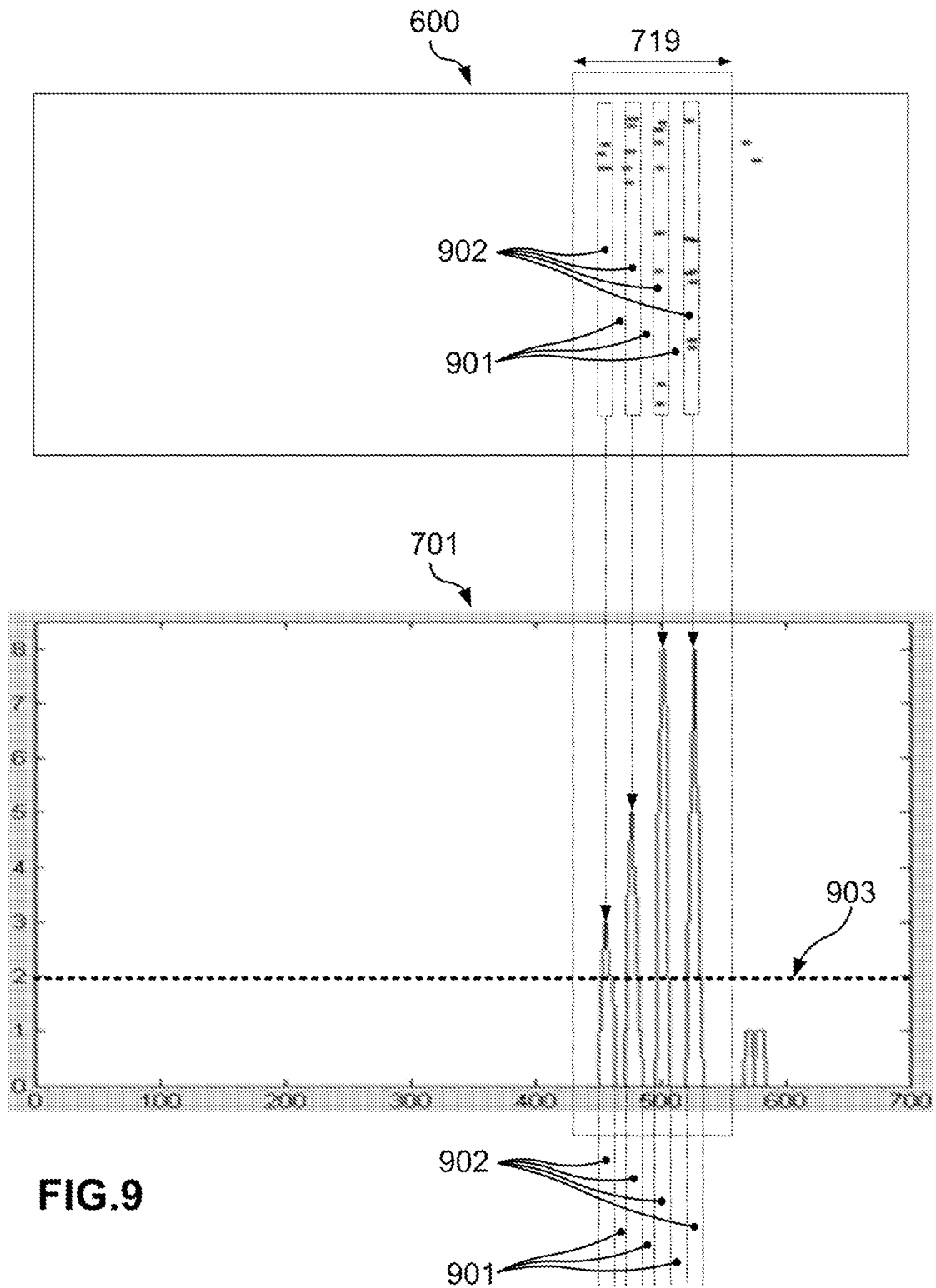


FIG.8



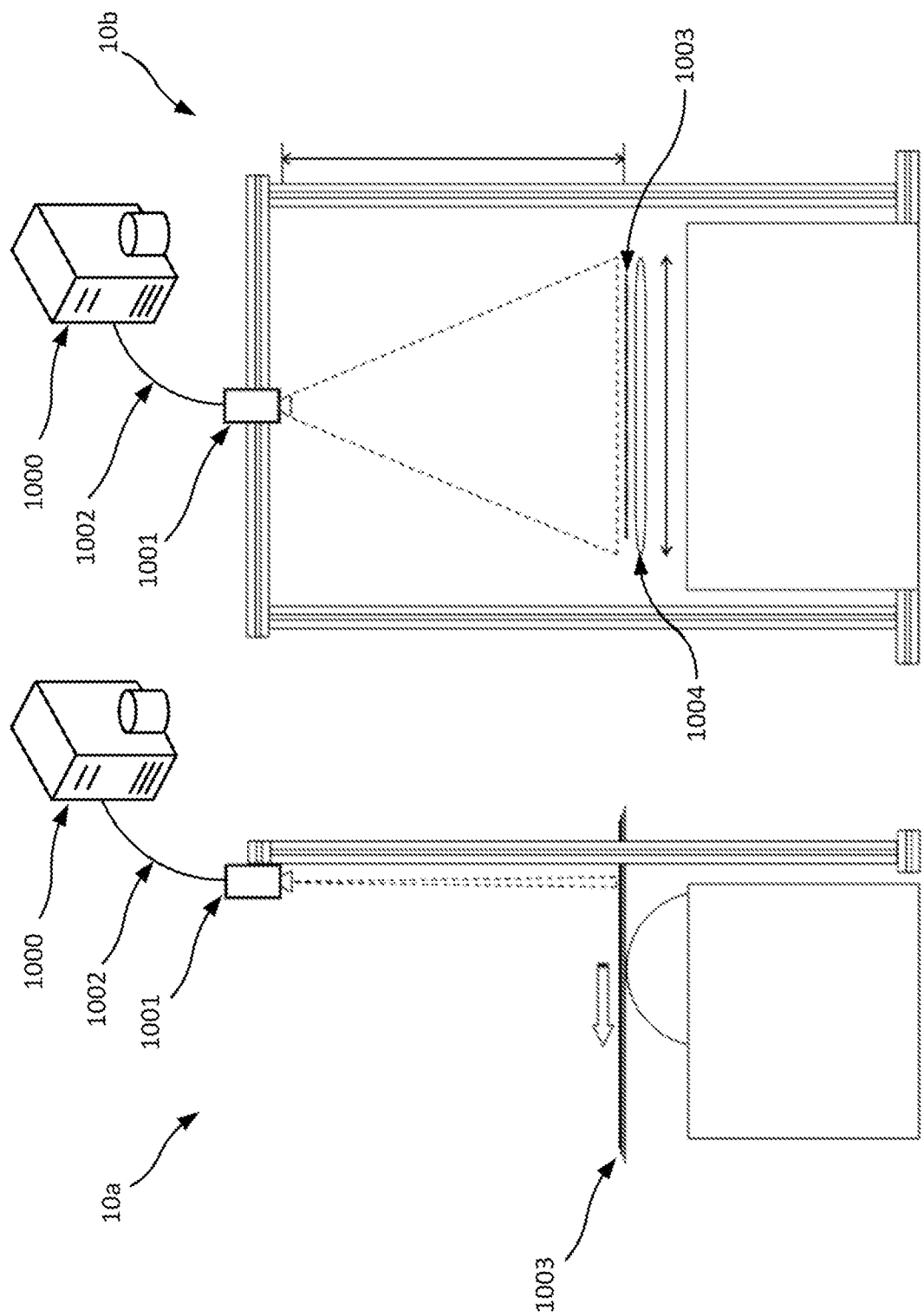


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/057719

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06T7/00
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06T

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, INSPEC, IBM-TDB, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	ABOUELELA A ET AL: "Automated vision system for localizing structural defects in textile fabrics", PATTERN RECOGNITION LETTERS, ELSEVIER, AMSTERDAM, NL, vol. 26, no. 10, 15 July 2005 (2005-07-15), pages 1435-1443, XP027779778, ISSN: 0167-8655 [retrieved on 2005-07-15] the whole document ----- -/--	1-17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

27 January 2012

Date of mailing of the international search report

08/02/2012

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Herter, Jochen

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2011/057719

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	HENRY Y T NGAN ET AL: "Automated fabric defect detection A review", IMAGE AND VISION COMPUTING, ELSEVIER, GUILDFORD, GB, vol. 29, no. 7, 27 February 2011 (2011-02-27), pages 442-458, XP028095511, ISSN: 0262-8856, DOI: 10.1016/J.IMAVIS.2011.02.002 [retrieved on 2011-03-24] the whole document -----	1-17
A	KUMAR A: "Computer-Vision-Based Fabric Defect Detection: A Survey", IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, IEEE SERVICE CENTER, PISCATAWAY, NJ, USA, vol. 55, no. 1, 1 January 2008 (2008-01-01), pages 348-363, XP011321122, ISSN: 0278-0046, DOI: 10.1109/TIE.1930.896476 the whole document -----	1-17
A	US 2001/031079 A1 (RYDER JOHN LEONARD [GB]) 18 October 2001 (2001-10-18) the whole document -----	1-17
A	NGAN H Y T ET AL: "Wavelet based methods on patterned fabric defect detection", PATTERN RECOGNITION, ELSEVIER, GB, vol. 38, no. 4, 1 April 2005 (2005-04-01), pages 559-576, XP004699639, ISSN: 0031-3203, DOI: 10.1016/J.PATCOG.2004.07.009 the whole document -----	1-17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2011/057719

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