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Mitsumoto

(54) **INFORMATION PROCESSING APPARATUS, INFORMATION PROCESSING METHOD, AND NON-TRANSITORY COMPUTER-READABLE STORAGE MEDIUM**

(71) Applicant: **CANON KABUSHIKI KAISHA**, Tokyo (JP)

(72) Inventor: **Shinichi Mitsumoto**, Saitama (JP)

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(57) **ABSTRACT**

An information processing apparatus obtains pieces of defect data respectively extracted from a plurality of images captured at different times and detects developing defects on the basis of differences between the pieces of defect data extracted from the images captured at the different times. The information processing apparatus further calculates priority levels of the defects on the basis of the differences between the pieces of defect data, specifies regions that cover the developing defects, and displays the specified regions in accordance with the priority levels.

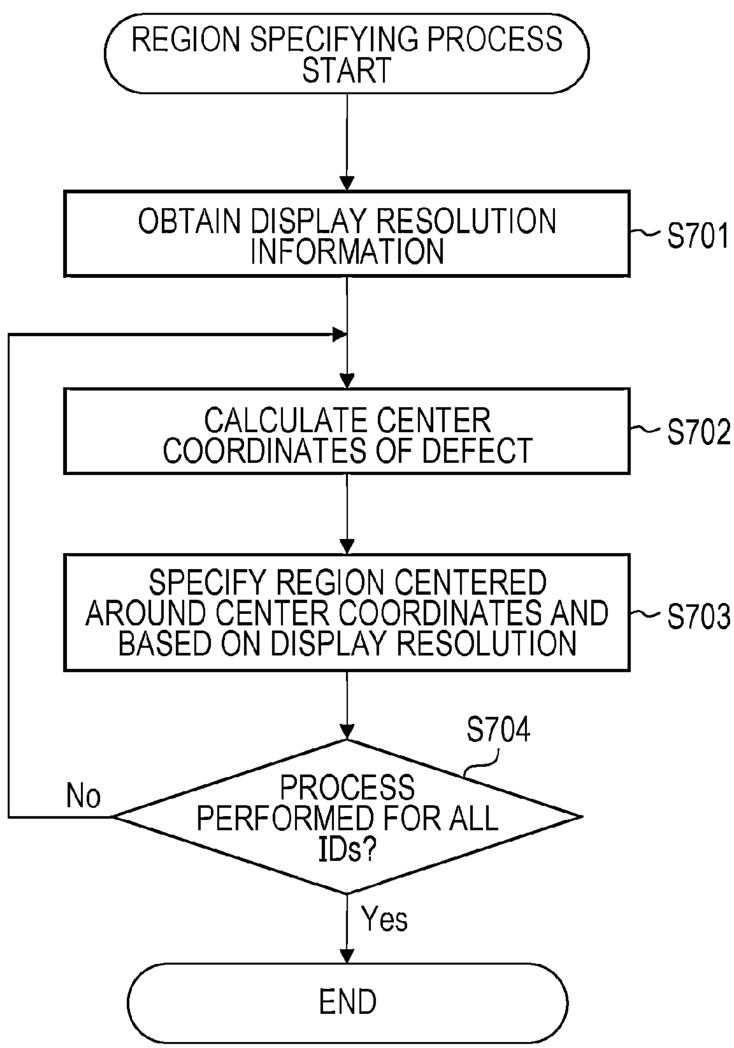


FIG. 1

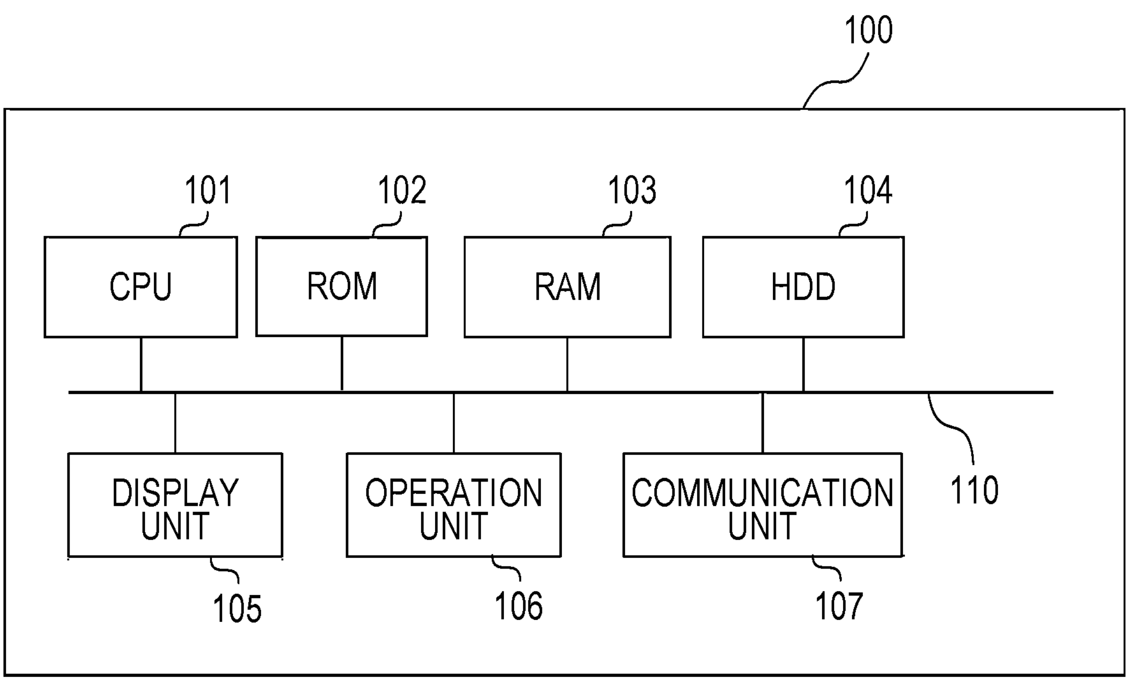

100
101
102
103
104
CPU
ROM
RAM
HDD
DISPLAY UNIT
OPERATION UNIT
COMMUNICATION UNIT
110
105
106
107

FIG. 2A

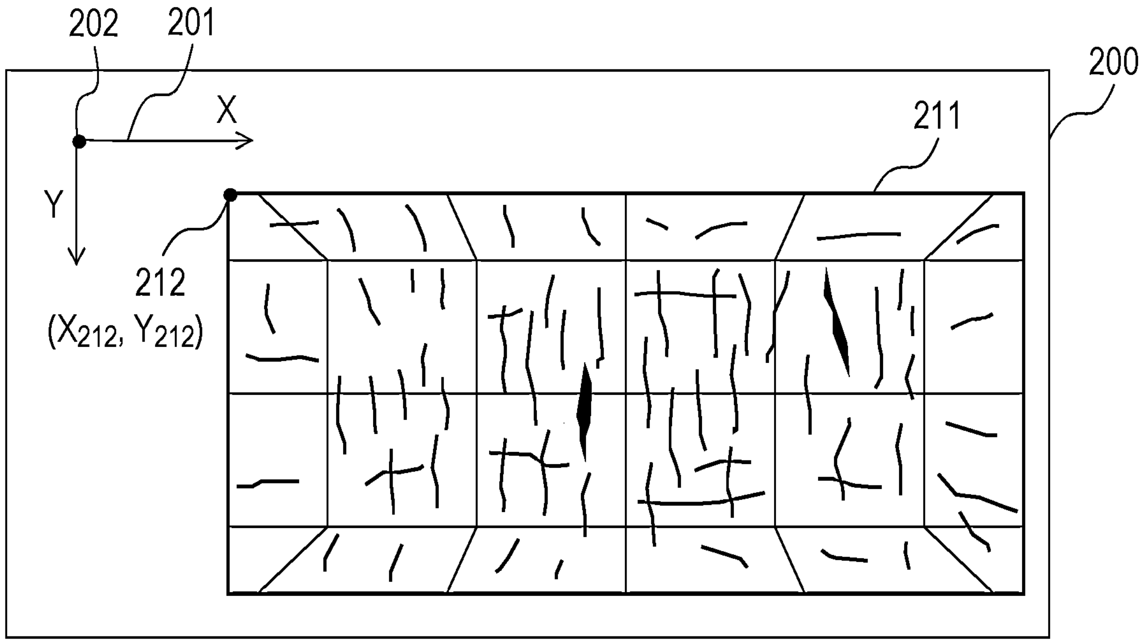

202
201
200
X
211
Y
212
(X_{212}, Y_{212})

FIG. 2B


202
201
200
X
221
Y
212
(X_{212}, Y_{212})

FIG. 3A

301

DEFECT ID	DEFECT TYPE	COORDINATES	LINE WIDTH	WIDTH MAXIMUM VALUE	LINE LENGTH	AREA
Ca001	CRACK	(Xca001_1,Yca001_1),···, (Xca001_n,Yca001_n)	0.5 mm, ···, 0.2 mm	0.8 mm	0.5 m	-
Ca002	CRACK	(Xca002_1,Yca002_1),···, (Xca002_m,Yca002_m)	0.3 mm, ···, 0.1 mm	0.4 mm	0.4 m	-
Ca003	CRACK	(Xca003_1,Yca003_1),···, (Xca003_p,Yca003_p)	1.2 mm, ···, 0.8 mm	1.2 mm	0.9 m	-
Ca004	CRACK	(Xca004_1,Yca004_1),···, (Xca004_p,Yca004_q)	0.4 mm, ···, 0.2 mm	0.4 mm	0.3 m	-
Ta001	EXPOSED REINFORCING ROD	(Xta001_1,Yta001_1),···, (Xta001_r,Yta001_r)	-	-	-	0.25 m^2
···	···	···	···	···	···	···
Caxxx	CRACK	(Xcaxxx_1,Ycaxxx_1),···, (Xcaxxx_s,Ycaxxx_s)	0.1 mm, ···, 0.2 mm	0.6 mm	0.7 m	-

FIG. 3B

302

DEFECT ID	DEFECT TYPE	COORDINATES	LINE WIDTH	WIDTH MAXIMUM VALUE	LINE LENGTH	AREA
Cb001	CRACK	(Xcb001_1,Ycb001_1),···, (Xcb001_n,Ycb001_n)	0.5 mm, ···, 0.2 mm	0.8 mm	0.8 m	-
Cb002	CRACK	(Xcb002_1,Ycb002_1),···, (Xcb002_m,Ycb002_m)	0.4 mm, ···, 0.2 mm	0.6 mm	0.4 m	-
Cb003	CRACK	(Xcb003_1,Ycb003_1),···, (Xcb003_p,Ycb003_p)	1.2 mm, ···, 0.9 mm	1.4 mm	1.2 m	-
Cb004	CRACK	(Xcb004_1,Ycb004_1),···, (Xcb004_p,Ycb004_q)	0.4 mm, ···, 0.2 mm	0.4 mm	0.3 m	-
Tb001	EXPOSED REINFORCING ROD	(Xtb001_1,Ytb001_1),···, (Xtb001_r,Ytb001_r)	-	-	-	0.30 m^2
···	···	···	···	···	···	···
Cbxxx	CRACK	(Xcbxxx_1,Ycbxxx_1),···, (Xcbxxx_s,Ycbxxx_s)	0.1 mm, ···, 0.2 mm	0.7 mm	0.7 m	-
Cbyyy	CRACK	(Xcbyyy_1,Ycbyyy_1),···, (Xcbyyy_t,Ycbyyy_t)	0.2 mm, ···, 0.2 mm	0.2 mm	0.1 m	-
Cbzzz	CRACK	(Xcbzzz_1,Ycbzzz_1),···, (Xcbzzz_u,Ycbzzz_u)	0.1 mm, ···, 0.1 mm	0.1 mm	0.1 m	-

FIG. 4

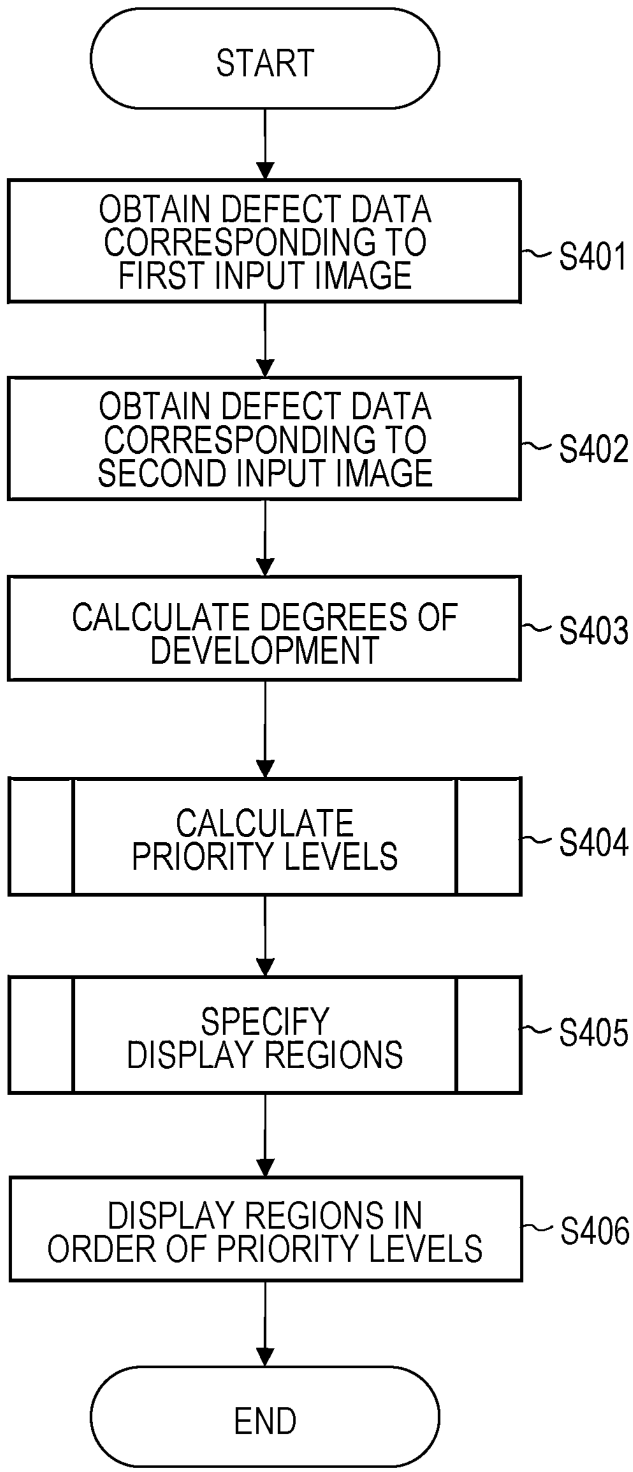

START
OBTAIN DEFECT DATA CORRESPONDING TO FIRST INPUT IMAGE
S401
OBTAIN DEFECT DATA CORRESPONDING TO SECOND INPUT IMAGE
S402
CALCULATE DEGREES OF DEVELOPMENT
S403
CALCULATE PRIORITY LEVELS
S404
SPECIFY DISPLAY REGIONS
S405
DISPLAY REGIONS IN ORDER OF PRIORITY LEVELS
S406
END

FIG. 5A

501

DEVELOPMENT ID	CORRESPONDING IDs	AMOUNT OF CHANGE IN LINE LENGTH	AMOUNT OF CHANGE IN LINE WIDTH	AMOUNT OF CHANGE IN AREA	AMOUNT OF CHANGE IN INTERSECTION POINTS	CONNECTION ID	PRIORITY LEVEL
C001_D	Ca001,Cb001	0.3 m	0.0 mm	–	0	–	
C002_D	Ca002,Cb002	0.0 m	0.3 mm	–	0	–	
C003_D	Ca003,Cb003	0.3 m	0.2 mm	–	0	–	
C004_D	Ca004,Cb004	0.0 m	0.0 mm	–	0	–	
T001_D	Ta001,Tb001	–	–	0.05 m^2	0	–	
...	...	...	...	...	...	...	...
Cxxx_D	Caxxx,Cbxxx	0.2 m	0.1 mm	–	2	Cbyyy, Cbzzz	

FIG. 5B

501

DEVELOPMENT ID	CORRESPONDING IDs	AMOUNT OF CHANGE IN LINE LENGTH	AMOUNT OF CHANGE IN LINE WIDTH	AMOUNT OF CHANGE IN AREA	AMOUNT OF CHANGE IN INTERSECTION POINTS	CONNECTION ID	PRIORITY LEVEL
C001_D	Ca001,Cb001	0.3 m	0.0 mm	–	0	–	6
C002_D	Ca002,Cb002	0.0 m	0.3 mm	–	0	–	3
C003_D	Ca003,Cb003	0.3 m	0.2 mm	–	0	–	8
C004_D	Ca004,Cb004	0.0 m	0.0 mm	–	0	–	0
T001_D	Ta001,Tb001	–	–	0.05 m^2	0	–	5
...	...	...	...	...	...	...	...
Cxxx_D	Caxxx,Cbxxx	0.2 m	0.1 mm	–	2	Cbyyy, Cbzzz	7

FIG. 6

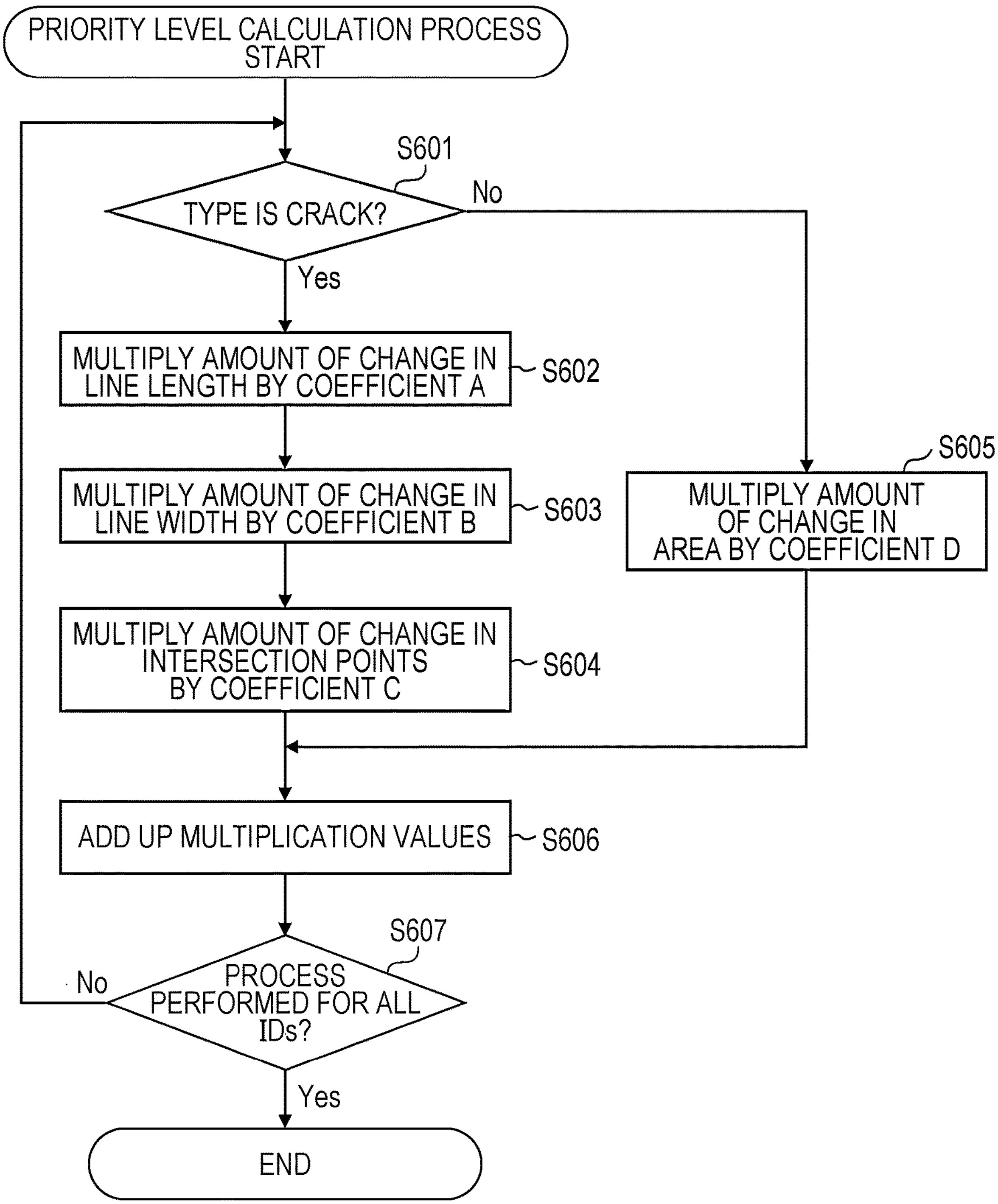

PRIORITY LEVEL CALCULATION PROCESS START
S601
TYPE IS CRACK?
No
Yes
MULTIPLY AMOUNT OF CHANGE IN LINE LENGTH BY COEFFICIENT A
S602
MULTIPLY AMOUNT OF CHANGE IN LINE WIDTH BY COEFFICIENT B
S603
MULTIPLY AMOUNT OF CHANGE IN INTERSECTION POINTS BY COEFFICIENT C
S604
S605
MULTIPLY AMOUNT OF CHANGE IN AREA BY COEFFICIENT D
ADD UP MULTIPLICATION VALUES
S606
S607
PROCESS PERFORMED FOR ALL IDs?
No
Yes
END

FIG. 7

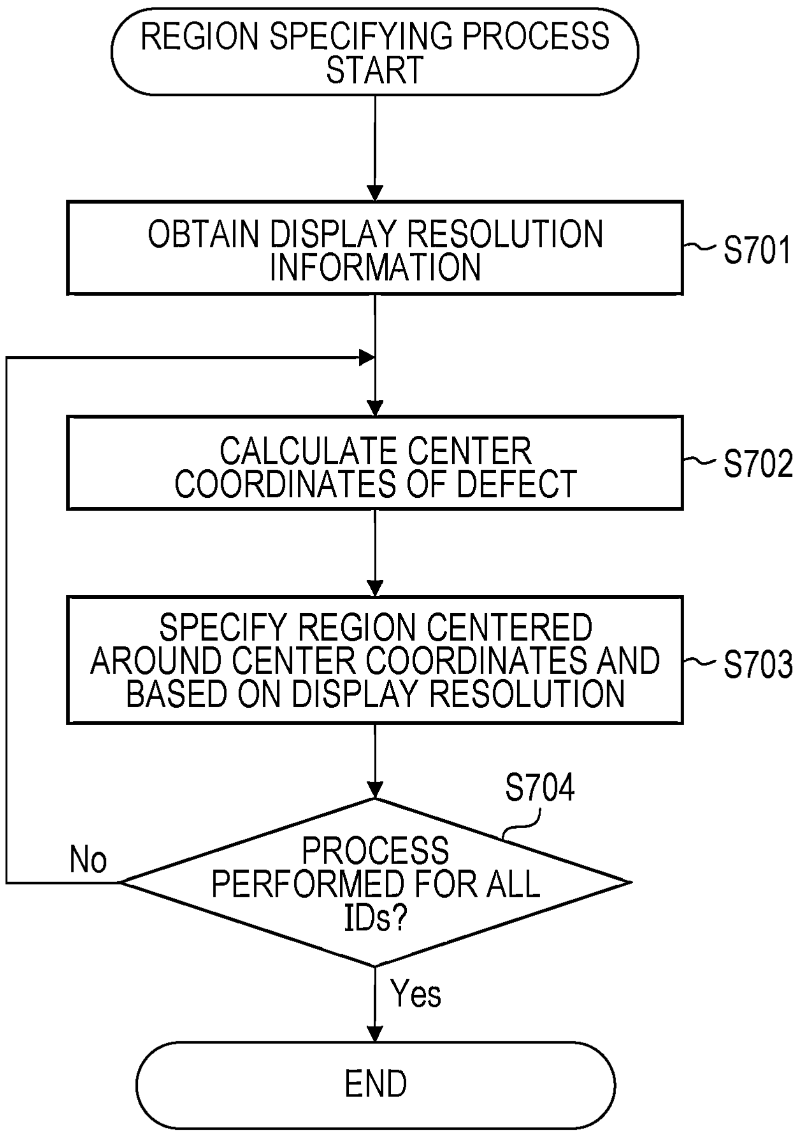

REGION SPECIFYING PROCESS START
OBTAIN DISPLAY RESOLUTION INFORMATION
S701
CALCULATE CENTER COORDINATES OF DEFECT
S702
SPECIFY REGION CENTERED AROUND CENTER COORDINATES AND BASED ON DISPLAY RESOLUTION
S703
S704
PROCESS PERFORMED FOR ALL IDs?
No
Yes
END

FIG. 8A

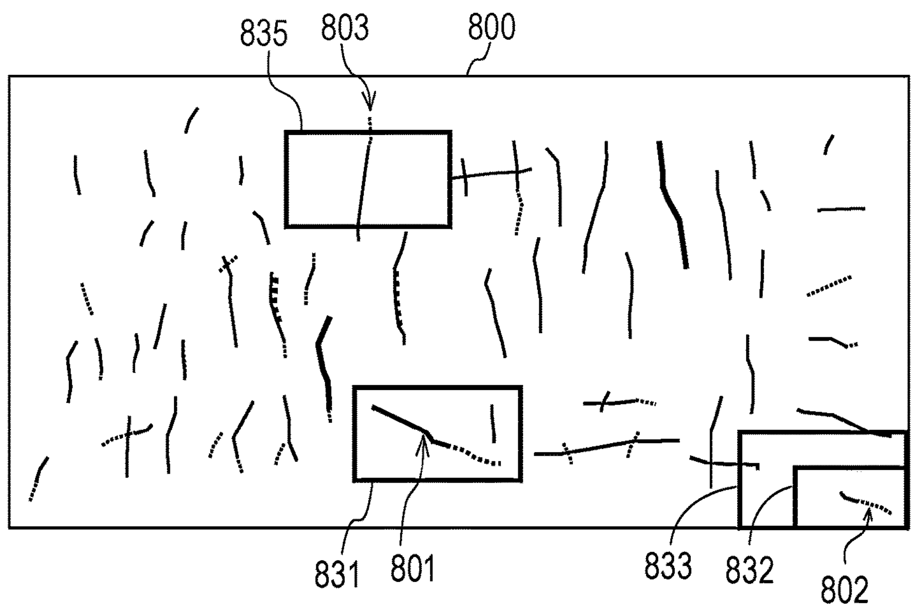


FIG. 8B

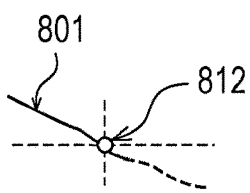


FIG. 8C

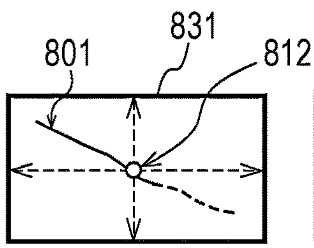


FIG. 8D

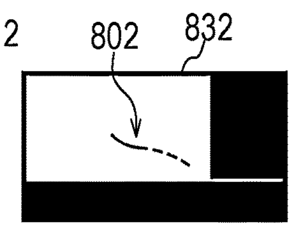


FIG. 8E

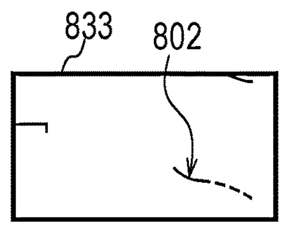


FIG. 8F

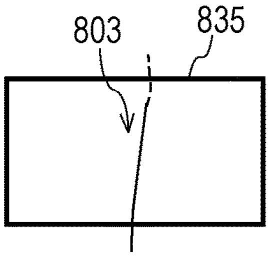


FIG. 8G

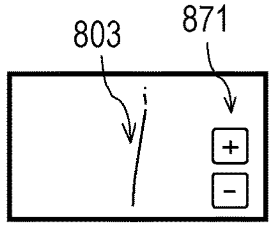


FIG. 8H

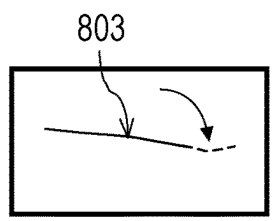


FIG. 8I

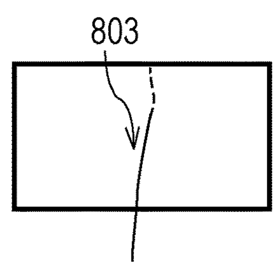


FIG. 9A

901

REGION ID	DEVELOPMENT ID	RECTANGLE COORDINATES	PRIORITY LEVEL
1	C003_D	(Xc003s,Yc003s), (Xc002e,Yc002e)	8
2	CXXX_D	(Xcxxxs,Ycxxxs), (Xcxxxe,Ycxxxe)	7
3	C001_D	(Xc001s,Yc001s), (Xc001e,Yc001e)	6
4	T001_D	(Xt001s,Yt001s), (Xt001e,Yt001e)	5
5	C002_D	(Xc002s,Yc002s), (Xc002e,Yc002e)	3
...	...	...	...
xx	C004_D	(Xc004s,Yc004s), (Xc004e,Yc004e)	0

FIG. 9B

951

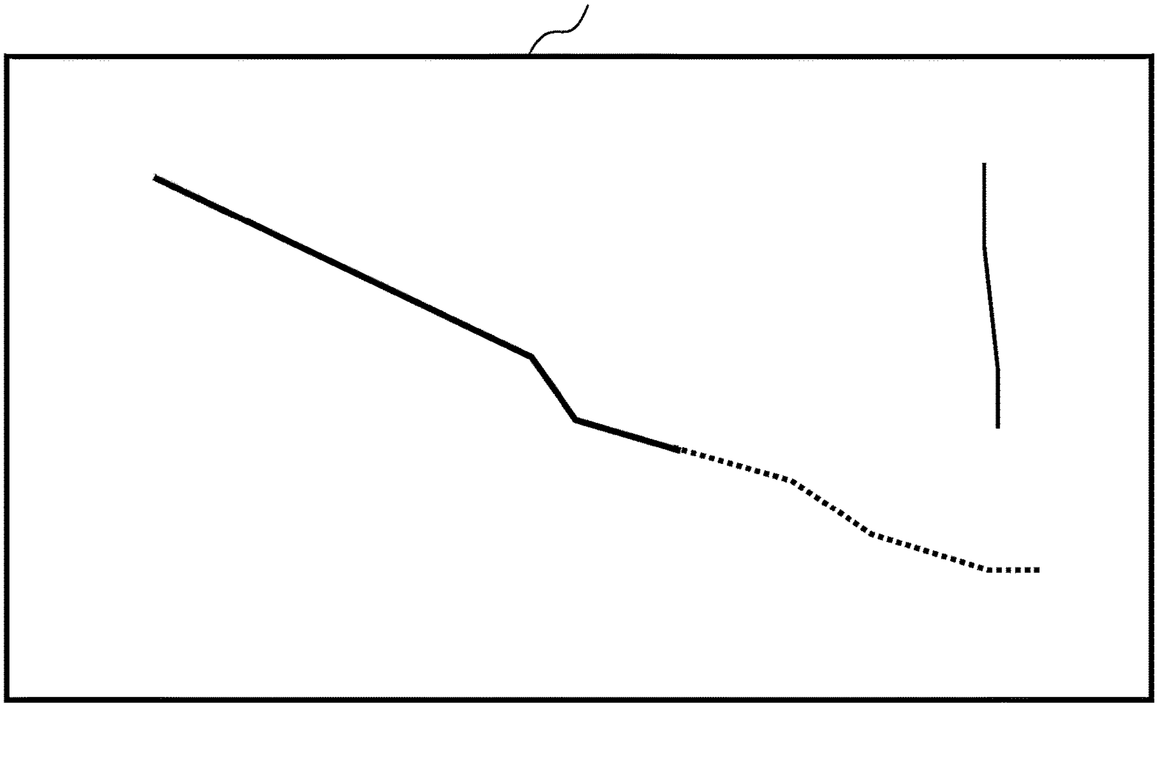


FIG. 10A

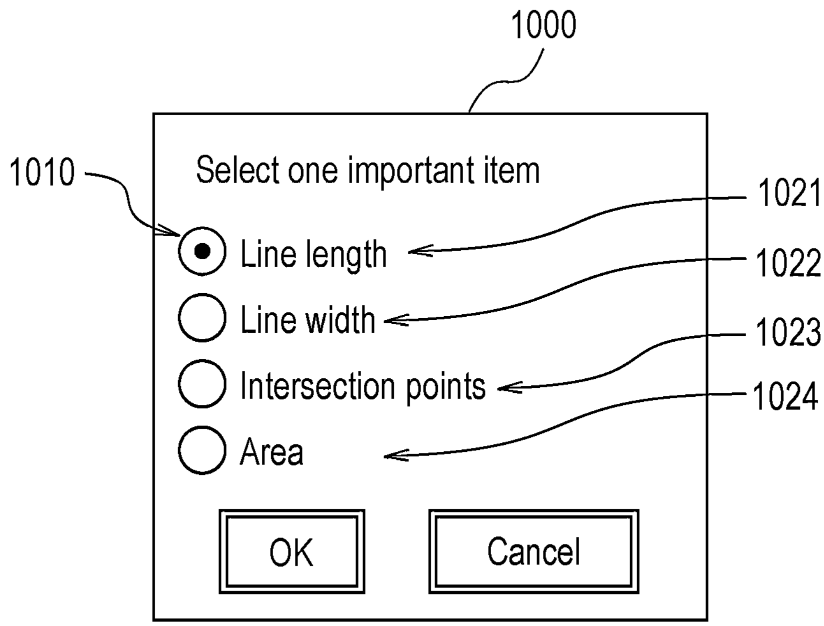


FIG. 10B

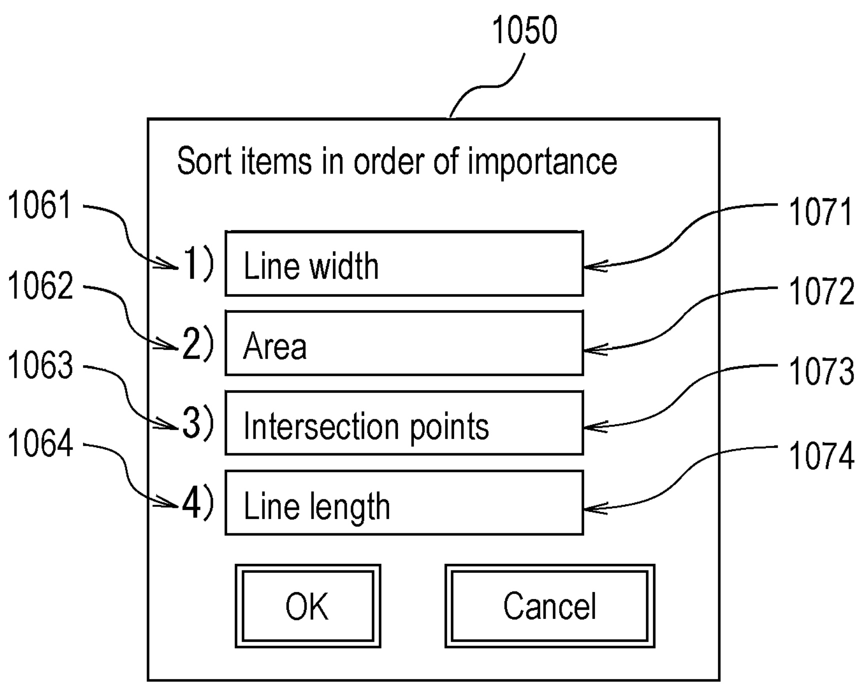


FIG. 11A

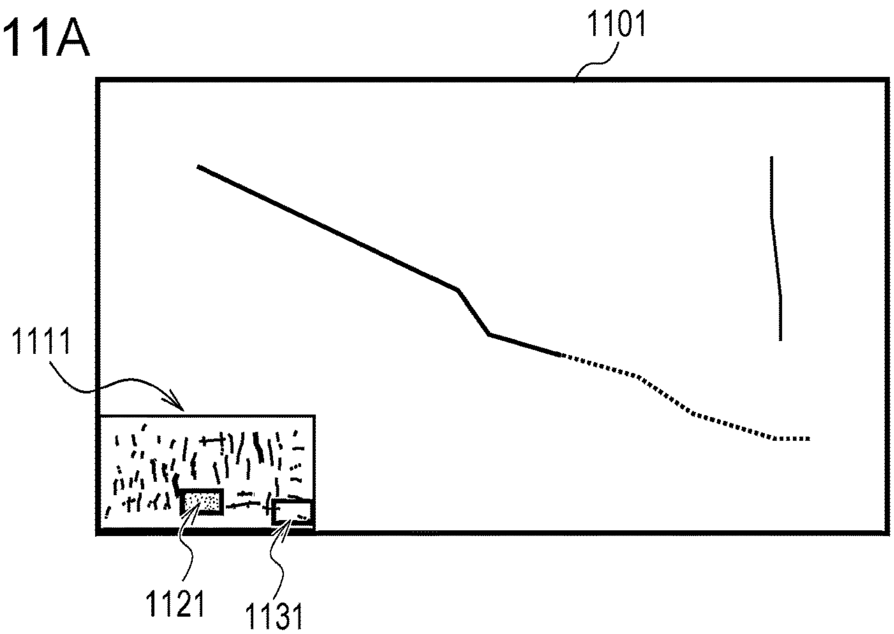


FIG. 11B

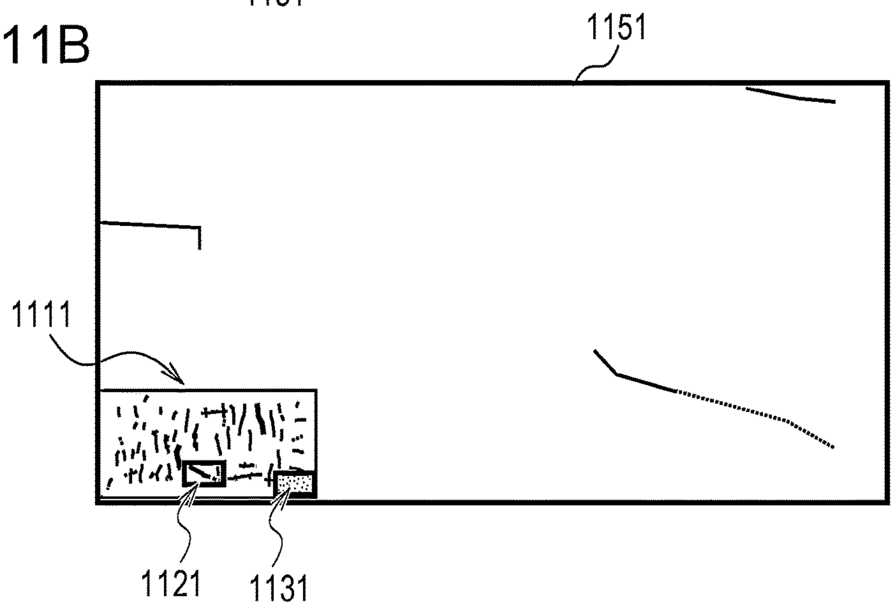


FIG. 11C

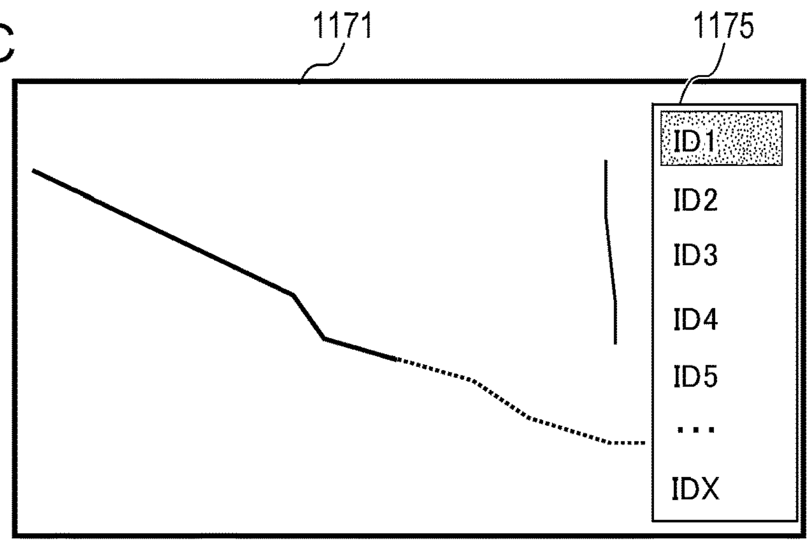


FIG. 12A

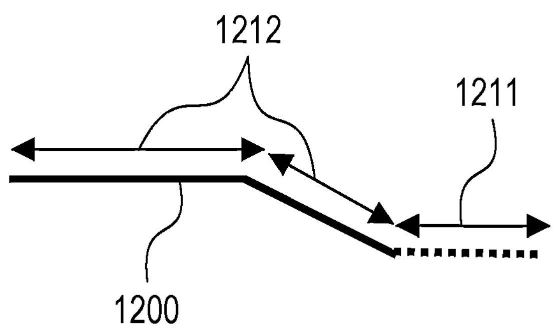


FIG. 12B

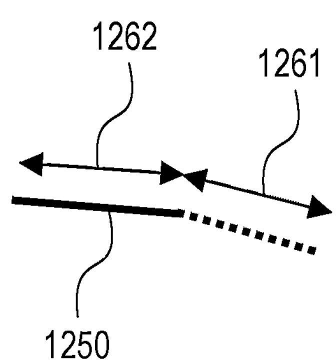


FIG. 13

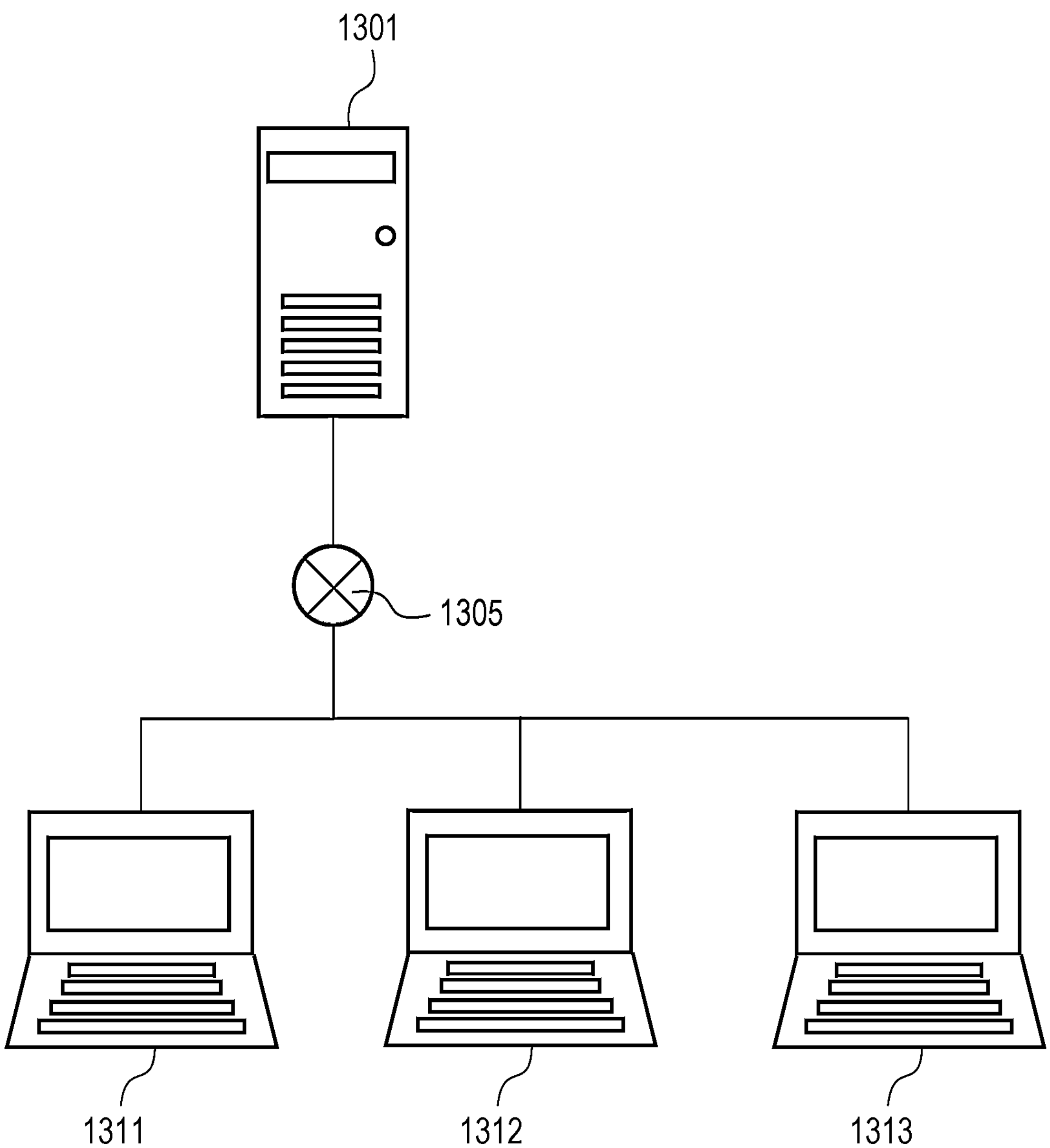


FIG. 14

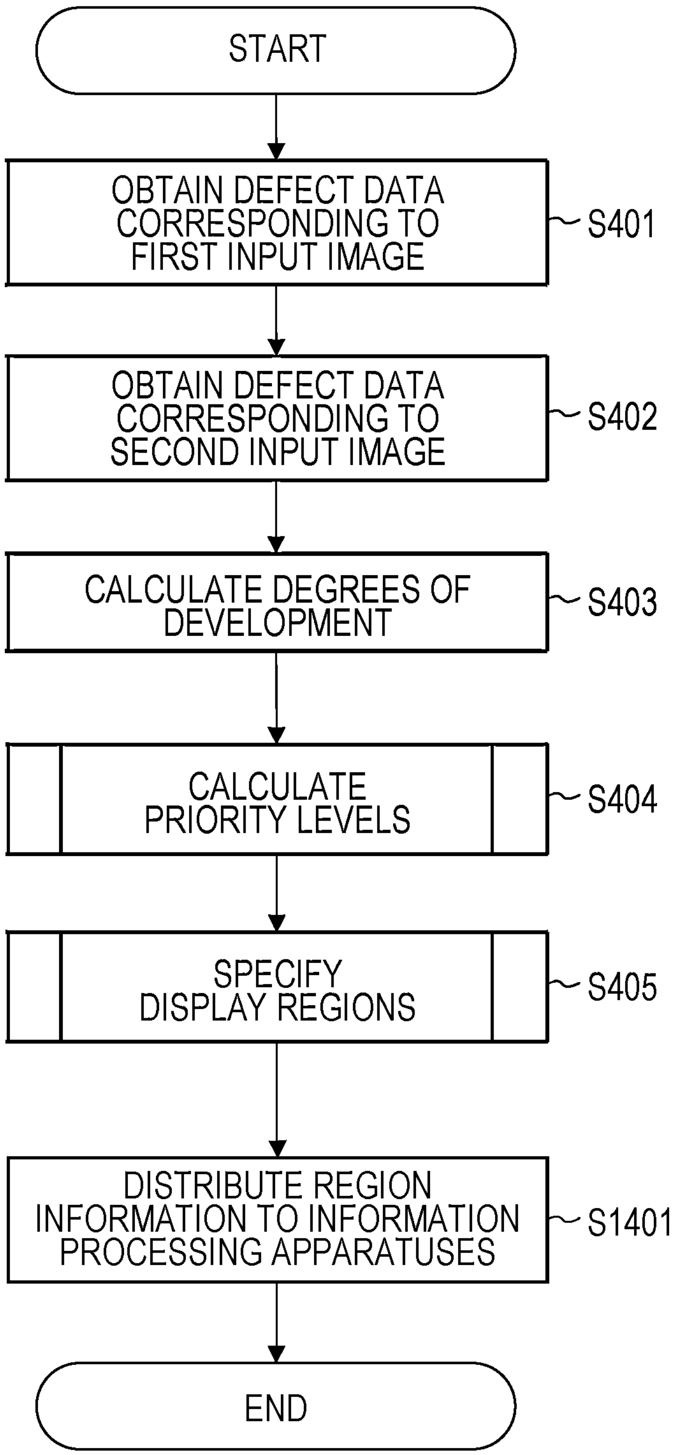
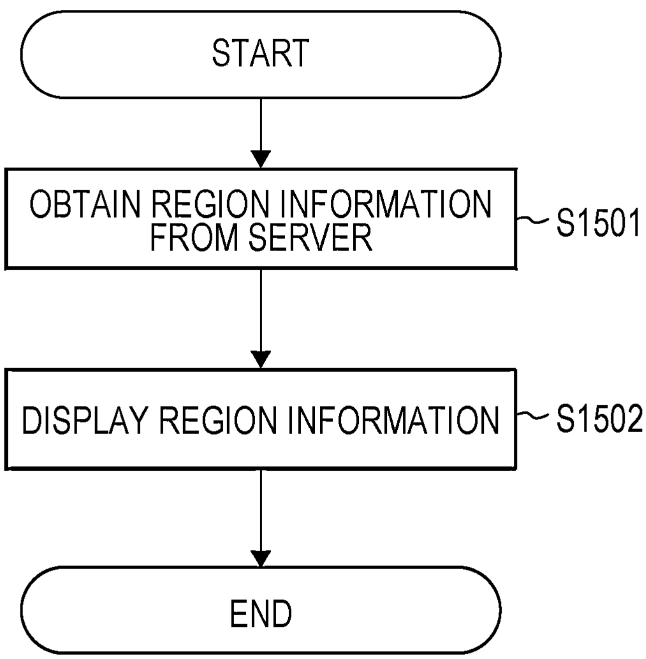

START
OBTAIN DEFECT DATA CORRESPONDING TO FIRST INPUT IMAGE
S401
OBTAIN DEFECT DATA CORRESPONDING TO SECOND INPUT IMAGE
S402
CALCULATE DEGREES OF DEVELOPMENT
S403
CALCULATE PRIORITY LEVELS
S404
SPECIFY DISPLAY REGIONS
S405
DISTRIBUTE REGION INFORMATION TO INFORMATION PROCESSING APPARATUSES
S1401
END

FIG. 15


START
OBTAIN REGION INFORMATION FROM SERVER
S1501
DISPLAY REGION INFORMATION
S1502
END

INFORMATION PROCESSING APPARATUS, INFORMATION PROCESSING METHOD, AND NON-TRANSITORY COMPUTER-READABLE STORAGE MEDIUM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of application Ser. No. 17/692,495, which was filed on Mar. 11, 2022 and which claims priority to Japanese Patent Application No. 2021-040480, which was filed on Mar. 12, 2021, both of which are hereby incorporated by reference herein in their entireties.

BACKGROUND

Field of the Disclosure

[0002] The present disclosure relates to an information processing technique for detecting defects in structures and the like on the basis of captured images.

Description of the Related Art

[0003] In inspection of an infrastructure, such as a bridge or a tunnel, by using images, a technique is employed in which a plurality of high-resolution images are captured and composited to generate one composite image in order to detect defects, such as cracks and exposed reinforcing rods, appearing on wall surfaces of the structure. Further, to determine the soundness of members of a structure, it is desirable to detect defects from images of wall surfaces of the structure captured at different times and grasp how far the defects have developed (that is, aging). In this case, the degree of development of each defect is calculated by, for example, obtaining the difference between detected defects.

[0004] Japanese Patent Laid-Open No. 2019-20220 discloses a technique in which images captured at different times are input, the position shift between defects is corrected, and thereafter, a developing defect is calculated.

[0005] Although a developing defect can be calculated by using the technique disclosed in Japanese Patent Laid-Open No. 2019-20220, for an image obtained by compositing a plurality of high-resolution images as described above, a large number of regions that include developing defects may be calculated. In this case, the operator who performs the inspection is to check the large number of regions that exhibit development and may overlook a defect region that is to be checked.

SUMMARY

[0006] Accordingly, some embodiments provide a technique for reducing the possibility of the operator overlooking a defect that is to be checked.

[0007] Some embodiments of the present disclosure provide an information processing apparatus including: an obtaining unit configured to obtain pieces of defect data respectively extracted from a plurality of images captured at different times; a detection unit configured to detect developing defects on the basis of differences between the pieces of defect data extracted from the images captured at the different times; a calculation unit configured to calculate priority levels of the defects on the basis of the differences between the pieces of defect data; a specifying unit configured to specify regions that cover the developing defects; and a display unit configured to display the specified regions in accordance with the priority levels.

[0008] Further features of various embodiments will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a diagram illustrating an example hardware configuration of an information processing apparatus.

[0010] FIGS. **2**A and **2**B are diagrams illustrating an example relationship between a drawing and an examination target image.

[0011] FIGS. **3**A and **3**B are diagrams illustrating example lists of detected defects.

[0012] FIG. **4** is a flowchart of information processing according to a first embodiment.

[0013] FIGS. **5**A and **5**B are diagrams illustrating an example list of developing defects.

[0014] FIG. **6** is a flowchart of a priority level calculation process.

[0015] FIG. **7** is a flowchart of a region specifying process.

[0016] FIGS. **8**A to **8**I are diagrams illustrating examples of specification of a region.

[0017] FIG. **9**A is a diagram illustrating an example of a region specification table and FIG. **9**B is a diagram illustrating an example of a check screen.

[0018] **10**A and **10**B are diagrams illustrating example user interface (UI) screens related to priority level changes.

[0019] FIGS. **11**A to **11**C are diagrams illustrating example UI screens related to region selection.

[0020] FIGS. **12**A and **12**B are diagrams illustrating an example of priority level calculation based on the degree of development (development rate).

[0021] FIG. **13** is a diagram illustrating an example system configuration according to a second embodiment.

[0022] FIG. **14** is a flowchart of information processing by a server according to the second embodiment.

[0023] FIG. **15** is a flowchart of information processing by a client terminal according to the second embodiment.

DESCRIPTION OF THE EMBODIMENTS

[0024] Hereinafter, some example embodiments will be described with reference to the drawings.

[0025] The following embodiments are not intended to limit every embodiment, and all combinations of features described in the embodiments might not be essential to every embodiment. Configurations according to the embodiments can be corrected or changed as appropriate on the basis of the specifications of an apparatus to which the present disclosure is applied and various conditions (the use conditions, use environment, and the like). Portions of embodiments described below may be combined as appropriate. In the following embodiments, the same configurations are assigned the same reference numerals to give descriptions thereof.

First Embodiment

[0026] FIG. **1** is a block diagram illustrating an example overall configuration of an information processing apparatus **100** according to this embodiment.

[0027] The information processing apparatus **100** includes a central processing unit (CPU) **101**, a read-only memory

(ROM) **102**, a random access memory (RAM) **103**, a hard disk drive (HDD) **104**, a display unit **105**, an operation unit **106**, and a communication unit **107**.

[0028] The CPU **101** performs calculation, logical determination, and the like for various processes and controls constituent elements connected to a system bus **110**. The ROM **102** is a program memory and stores a program that includes a control procedure and an information processing procedure and that is executed by the CPU **101**. The program stored in the ROM **102** includes a program of various information processing procedures according to this embodiment described below. The RAM **103** is used as a temporary memory area that serves as the main memory, a work area, and the like of the CPU **101**. Note that the program memory may be implemented as a process of loading the program to the RAM **103** from an external storage device or the like connected to the information processing apparatus **100**.

[0029] The HDD **104** is a device that includes a hard disk for storing electronic data, such as image data, and a program according to this embodiment. As a device that plays a role similar to that of the HDD **104**, an external storage device may be used. The external storage device can be implemented as, for example, a medium (recording medium) and an external storage drive that enables access to the medium. Examples of the medium include a flexible disk (FD), a compact disc read-only memory (CD-ROM), a digital versatile disc (DVD), a universal serial bus (USB) memory, a magneto-optical (MO) disk, and a flash memory. The external storage device may be, for example, a server connected via a network.

[0030] The display unit **105** includes, for example, a liquid crystal display (LCD) or an organic electroluminescence display (OELD), and generates and displays on the screen of any of these displays, an image or a graphical user interface (GUI). Note that the display unit **105** may be included in an external device that is connected to the information processing apparatus **100** by wire or wirelessly.

[0031] The operation unit **106** includes a keyboard and a mouse and accepts various operations performed by a user, such as an operator performing defect investigation and inspection described below.

[0032] The communication unit **107** performs wired or wireless bidirectional communication with another information processing apparatus, a communication device, an external storage device, and the like on the basis of a publicly known communication technique.

[0033] The information processing apparatus **100** according to this embodiment detects defects, such as cracks and exposed reinforcing rods, appearing on an infrastructure, such as a bridge or a tunnel, from captured high-resolution images of the infrastructure and determines aging that indicates how far the defects have developed. The information processing apparatus **100** according to this embodiment further calculates priority levels on the basis of the degrees of importance of the developing defects and changes the display method for the regions of the developing defects on the basis of the priority levels. Specifically, the information processing apparatus **100** according to this embodiment obtains pieces of defect data respectively extracted from a plurality of images captured at different times, calculates differences between the pieces of defect data respectively extracted from the images captured at the different times, and detects developing defects on the basis of the differences. The information processing apparatus **100** according to this embodiment calculates the priority levels of the defects on the basis of the differences between the pieces of defect data, specifies regions that cover the developing defects, and displays the specified regions in accordance with the priority levels.

[0034] Before a detailed description of the information processing apparatus **100** according to this embodiment is given, a relationship between an image and defect data indicating defects, and structural information regarding an infrastructure or the like will be described. In inspection using images, it is desirable to manage captured images of wall surfaces and the like of a structure in association with a drawing of the structure.

[0035] FIG. **2**A is a diagram illustrating a state where an image **211** that is a captured image of a wall surface of a bridge, which is an example infrastructure, is superimposed on an image of a drawing **200**. The image of the drawing **200** has a drawing coordinate system **201** having a point **202** as the origin. The position of the image on the drawing is defined by the coordinates of the vertex at the top left of the image. For example, the position of the image **211** is defined by the coordinates (X_{212}, Y_{212}) of a vertex **212**. The image data of the drawing **200** and data of the image **211** are stored in the RAM **103** and the HDD **104**, which are storage units, together with coordinate information of the drawing **200** and that of the image **211**.

[0036] In this embodiment, an image used in an image inspection of an infrastructure is captured at a high resolution such that, for example, one pixel corresponds to 1 mm on the structure so as to enable checking of a very small crack and the like, and therefore, has a large size. For example, it is assumed that the image **211** in FIG. **2**A is a captured image of a slab of a bridge with dimensions of 20 m×10 m. In a case where the image resolution is 1.0 mm per pixel (1.0 mm/pixel), the image size of the image **211** is equal to 20,000 pixels×10,000 pixels. In a case where, for example, a large number of defects including cracks and exposed reinforcing rods are present in 1000 locations or more in the image **211** captured at a high resolution, it is difficult to show all of the defects on the figure, and therefore, some of the defects are shown in FIGS. **2**A and **2**B. In figures that are referred to in the following description and that show an image or defect data of a wide area, defects shown on the figures are limited to some defects.

[0037] Defect data is information about the result of automatic detection of defects detected (extracted) from a captured image by performing an image analysis process for defects, such as cracks, appearing on a concrete wall surface, or information that is a record obtained as a result of input by a person who determines defects from a captured image. The information processing apparatus **100** according to this embodiment obtains defect data thus extracted from a captured image. The description of this embodiment is given under the assumption that an input image and defect data are managed in association with drawing coordinates.

[0038] FIG. **2**B illustrates a state where defect data **221** corresponding to the image **211** is superimposed on the image of the drawing **200** at a position the same as the position of the image **211** in FIG. **2**A. The defect data **221** includes a large number of defects (for example, 1000 or more defects) including defects not shown on the figure. The position, on the drawing, of each defect in the defect data **221** is defined by the coordinates of each pixel that forms the defect.

[0039] FIG. **3**A is a diagram illustrating an example of a defect data table **301** that shows the data structure of defect data. A description of a defect data table **302** illustrated in FIG. **3**B will be described below.

[0040] The defect data table **301** includes items, namely, a defect ID, a defect type, coordinates, a line width, a width maximum value, a line length, and an area. The defect ID indicates identification information (ID) of a detected defect, and the defect type indicates the type of defect, such as "crack" or "exposed reinforcing rod". The coordinates include a plurality of pieces of coordinate information of pixels that form a defect. The line width includes attribute values each indicating the width of a defect at a position indicated by the corresponding coordinates in a case where the defect type is "crack". The width maximum value indicates the maximum numerical value of the line width in a case where the defect type is "crack", and the line length indicates the total length of a crack. The area indicates, in a case where the defect type is, for example, "exposed reinforcing rod", which is a defect having a region, the area of the region. For example, regarding a defect ID Ca001, the defect type is "crack", and the coordinates include (Xca001_1, Yca001_1) to (Xca001_n, Yca001_n), which are sets of coordinates of n contiguous pixels.

[0041] As described above, this embodiment assumes that defect data is expressed by pixels. Defect data may be expressed by vector data of, for example, a polyline or a curve formed of a plurality of points. In a case where defect data is expressed by vector data, the data amount is reduced and the expression becomes more simplified. A defect ID Ta001 is an example of a defect, other than a crack, having a region shape, and the defect type is "exposed reinforcing rod". In a case where, for example, an exposed reinforcing rod having a region shape is expressed by coordinate information, the defect has a region outlined by a polyline. Note that information included in defect data is not limited to the information included in the defect data table **301**, and information about the other attributes may be retained.

[0042] The information about the other attributes may include structural information concerning the structure of the examination target. The structural information is information including the type and basic structure of the structure, various dimensions of the structure, member information, the year of completion, and other specifications. The information about the other attributes may include information about repair records concerning maintenance, including the years of repairs, repaired portions, and repair methods. This embodiment assumes that structural information regarding specific positions in the structure, such as member information and repair information, is stored together with information about the positions on the drawing. That is, the position of each member on the drawing and the positions of repaired portions on the drawing are stored as part of the structural information. Therefore, a correspondence between the structural information and the image and defect data can be obtained with reference to the drawing. The structural information is stored in the RAM **103** and the HDD **104**, which are storage units, together with the image and defect data and can be obtained from the RAM **103** or the HDD **104**. Note that information included in the structural information is not limited to the above-described information, and other information may be further retained. In accordance with the type of structure, information specific to the type may be retained.

[0043] FIG. **4** is a main flowchart illustrating a flow of an aging priority display process, which is information processing performed by the information processing apparatus **100** according to this embodiment. The information processing apparatus **100** according to this embodiment uses two images (a first input image and a second input image) captured at different times and calculates the degrees of development of defects appearing on a wall surface of a structure. It is assumed that the time when the second input image was captured is the time after the elapse of several years (for example, five years) since the time when the first input image was captured. In the following description, each step in FIG. **4** is described with the prefix "S" added to its reference numeral.

[0044] In S**401**, the CPU **101** obtains defect data (first defect data) corresponding to the first input image from among pieces of defect data stored in a storage unit. It is assumed that the first defect data is data obtained from the defect data table **301** illustrated in FIG. **3**A. As the defect data, for example, crack data is described here. It is assumed that the crack data is, for example, information input by manually tracing cracks on the image or information obtained by automatic detection using a model trained in advance through machine learning, and is data stored in a storage unit.

[0045] In S**402**, the CPU **101** obtains defect data (second defect data) corresponding to the second input image as in S**401**. It is assumed that the defect data corresponding to the second input image is included in, for example, the defect data table **302** illustrated in FIG. **3**B. The defect data table **302** illustrated in FIG. **3**B is a table similar to the defect data table **301** described above and illustrated in FIG. **3**A. Similar to the defect data table **301**, it is assumed that the defect data table **302** illustrated in FIG. **3**B includes information input by manual tracing on the second input image or information obtained by automatic detection using a model trained through machine learning, and is data stored in advance in a storage unit. That is, the CPU **101** obtains the second defect data corresponding to the second input image from the defect data table **302** stored in a storage unit.

[0046] Next, in S**403**, the CPU **101** calculates difference values from the first defect data and the second defect data and creates an aging data table **501** illustrated in FIGS. **5**A and **5**B as information indicating the degrees of development of defects.

[0047] FIG. **5**A illustrates the aging data table **501** obtained by calculating difference values from the first defect data and the second defect data. The aging data table **501** illustrated in FIG. **5**B will be described below.

[0048] The aging data table **501** includes items, namely, a development ID, corresponding IDs, the amount of change in line length, the amount of change in line width, the amount of change in area, the amount of change in intersection points, a connection ID, and a priority level. The development ID indicates the ID of a developing defect. The corresponding IDs are the defect IDs of defects that are compared with each other and include a defect ID in the first defect data and a defect ID in the second defect data. The first defect data and the second defect data may be associated with each other by using an existing technique. For example, from the outlines of defects extracted from the first input image and from the outlines of defects extracted from the second input image, centers of gravity and feature values may be calculated, and the distance between calculated feature values and the distance between other calculated feature values may be compared with each other to thereby perform alignment. The amount of change in line length, the amount of change in line width, the amount of change in area, and the amount of change in intersection points are each indicated as a difference value between the first defect data and the second defect data. Specifically, the amount of change in line length is calculated as the difference between a line length for a defect ID in the first defect data and a line length for a defect ID in the second defect data, the defect IDs being included in the corresponding IDs. Similarly, the amount of change in line width is calculated as the difference in the line width maximum value between the first defect data and the second defect data, and the amount of change in area is calculated as the difference in the area between the first defect data and the second defect data. The amount of change in intersection points is calculated from the difference between the number of intersection points in a defect in the first defect data and the number of intersection points in a corresponding defect in the second defect data. The connection ID includes the defect ID of a defect in the second defect data newly detected for a corresponding defect in the first defect data.

[0049] Next in S**404**, the CPU **101** performs a process for calculating priority levels that are to be checked by the operator, on the basis of the degrees of importance of developing defects, and includes the priority levels in the item of priority level of the aging data table. This process will be described in detail below with reference to the flowchart in FIG. **6**.

[0050] Next, in S**405**, the CPU **101** specifies regions (regions of interest) that are displayed as portions to which the operator is to pay attention to check development of defects. This process will be described in detail below with reference to the flowchart in FIG. **7**.

[0051] Next, in S**406**, the CPU **101** displays the regions of interest specified in S**405** on the display unit **105** one by one, in order of the priority levels calculated in S**404** for defects included in the regions. After the operator has checked the region displayed on the display unit **105**, the operator, for example, clicks the mouse or presses a specific key of the keyboard included in the operation unit **106**. Accordingly, the CPU **101** recognizes that checking by the operator is completed. The CPU **101** displays on the display unit **105** a region having a priority level subsequent to a priority level corresponding to the currently displayed region.

[0052] FIG. **6** is a flowchart illustrating a detailed flow of the priority level calculation process in S**404** in FIG. **4**.

[0053] In S**601**, the CPU **101** performs a process for development IDs included in the aging data table **501** sequentially and determines the type of defect for a processing target development ID. In the priority level calculation process, a priority level calculation reference differs depending on the type of defect, and therefore, the CPU **101** first determines the type of defect for the processing target development ID in S**601**. Here, it is assumed that the CPU **101** determines whether the type of defect for the processing target development ID is "crack". If the type of defect is "crack" (Yes), the CPU **101** proceeds to the process in S**602**. If the type of defect is not "crack" (No), the CPU **101** proceeds to the process in S**605**.

[0054] When the process proceeds to S**602**, the CPU **101** multiples the value of the amount of change in line length for the target development ID in the aging data table **501** by a coefficient A. In this embodiment, the coefficient A is set to 20. In a case of the aging data table **501**, the CPU 101 multiples 0.3, which is the amount of change in line length for a development ID C001_D, to thereby obtain 6 as the multiplication value.

[0055] Next, in S**603**, the CPU **101** multiples the value of the amount of change in line width for the target development ID in the aging data table **501** by a coefficient B. In this embodiment, the coefficient B is set to 10. In the case of the aging data table **501**, the CPU **101** multiplies 0.0, which is the amount of change in line width for the development ID C001_D, to thereby obtain 0 as the multiplication value.

[0056] Next, in S**604**, the CPU **101** multiples the value of the amount of change in intersection points for the target development ID in the aging data table **501** by a coefficient C. In this embodiment, the coefficient C is set to 1. In the case of the aging data table **501**, the CPU **101** multiplies 0, which is the amount of change in intersection points for the development ID C001_D, to thereby obtain 0 as the multiplication value. After S**604**, the CPU **101** proceeds to the process in S**606**.

[0057] In a case where the process proceeds to S**605**, the CPU **101** multiples the value of the amount of change in area for the target development ID in the aging data table **501** by a coefficient D. In this embodiment, the coefficient D is set to 100. In the case of the aging data table **501**, the CPU **101** multiplies 0.05, which is the amount of change in area for a development ID T001_D, to thereby obtain 5 as the multiplication value. After S**605**, the CPU **101** proceeds to the process in S**606**.

[0058] The values of the coefficients A to D are set so as to weight the priority level such that the amount of change in line length>the amount of change in line width>the amount of change in area>the amount of change in intersection points holds. For example, the coefficient A is set to 20, the coefficient B is set to 10, the coefficient C is set to 1, and the coefficient D is set to 100. These coefficients may be changed on the basis of values in the aging data table **501**. For example, the coefficient values may be set on the basis of normalization based on a unit of, for example, m (meter) or mm (millimeter).

[0059] Next, in S**606**, the CPU **101** adds up the multiplication values obtained in S**602** to S**604** or the multiplication value obtained in S**605** and includes the resulting value in the item of priority level in the aging data table **501** as illustrated in FIG. **5**B.

[0060] Subsequently, in S**607**, the CPU **101** determines whether the process has been performed for all development IDs. If the process has been performed for all development IDs (Yes), the CPU **101** ends the process in the flowchart in FIG. **6**. If a development ID for which the process is not yet performed is present (No), the development ID for which the process is not yet processed is assumed to be the processing target ID, and the process returns to S**601**.

[0061] FIG. **7** is a flowchart illustrating a detailed flow of the region-of-interest specifying process in S**405** in FIG. **4**.

[0062] In S**701**, the CPU **101** obtains information about the display resolution of the display of the display unit **105** in the information processing apparatus **100**. Here, it is assumed, for example, that the display is a liquid crystal display and the display resolution is that of full High Definition (HD). It is assumed that the display resolution of full HD is 1920×1080.

[0063] In S**702**, the CPU **101** obtains coordinate information of defect data for a processing target defect ID from the defect data table **302** illustrated in FIG. **3**B and calculates the coordinates of the center. As the calculation method, a method can be used in which, for example, the average of the maximum value and the minimum value of the X coordinate in the horizontal direction and the average of the maximum value and the minimum value of the Y coordinate in the vertical direction among the coordinates in the defect data table are assumed to be the center coordinates (Xm, Ym).

[0064] Regarding the process in S**702**, a supplementary explanation will be given with reference to FIG. **8**A to FIG. **8**I.

[0065] FIG. **8**A is a diagram illustrating, for example, a developing defect superimposed image **800** and a crack **801**.

[0066] The developing defect superimposed image **800** is an example image obtained by superimposing and displaying cracks detected as defects on the second input image. In the example in the figure, the crack **801** is formed of a solid-line portion and a dotted-line portion. The solid-line portion depicts a crack obtained from the first defect data, and the dotted-line portion depicts a crack obtained from the second defect data, that is, a portion that has developed due to aging. Although the existing portion is depicted by a solid line and the developing portion is depicted by a dotted line for convenience of explanation, another method may be employed in which the developing portion is highlighted and displayed by, for example, changing the color of the developing portion or making the line thicker.

[0067] FIG. **8**B is a diagram illustrating a center **812** of the crack **801**, and the coordinates of the center **812** are (Xm, Ym). Although the average values are calculated as the coordinates of the center **812** in this example, a method in which the value of center of gravity is calculated may be used or another method may be used.

[0068] Next, in S**703**, the CPU **101** sets a rectangular region that covers the defect on the basis of the coordinates of the center **812** (center coordinates) calculated in S**702** and the display resolution obtained in S**701** and saves information about the rectangular region in a region table, an example of which is illustrated in FIG. **9**A described below. For example, it is assumed that the display resolution obtained in S**701** is 1920×1080 and the center coordinates obtained in S**702** are (Xm, Ym). Then, the rectangular region is expressed as a region for which the top left coordinates are (Xm−960, Ym−540) and the bottom right coordinates are (Xm+960, Ym+540).

[0069] FIG. **9**A is a diagram illustrating an example of a region table **901**.

[0070] The region table **901** includes items, namely, a region ID, a development ID, rectangle coordinates, and a priority level. The development ID and the priority level are the development ID and the priority level in the aging data table illustrated in FIG. **5**A or **5**B, and region IDs are assigned in order of priority level. The rectangle coordinates include the top left coordinates and the bottom right coordinates of the rectangular region described above.

[0071] FIG. **8**C is a diagram illustrating an example where a rectangular region outlined by an outer frame **831** and centered around the center **812** of the crack **801** is calculated.

[0072] FIG. **9**B is a diagram illustrating an example of a check screen **951** that is displayed on the display unit **105**. The check screen **951** is a screen obtained by cutting the rectangular region from the developing defect superimposed image **800**.

[0073] There may be a crack, such as a crack **802** in FIG. **8**A, for which the center is close to an edge portion (the top side, the bottom side, the left-hand side, or the right-hand side) of the developing defect superimposed image **800** and it is not possible to set a rectangular region based on the display resolution. In this case, a rectangular region outlined by an outer frame **832** in which the region outside the image is blacked out as illustrated in FIG. **8**D may be generated. Another method may be employed in which a rectangular region outlined by an outer frame **833** is set such that the portion outside the edge portion is not selected and the center of the defect does not correspond to the center of the rectangular region as illustrated in FIG. **8**E.

[0074] In this embodiment, although an example is described where a region is displayed at the same magnification on the display screen, the magnification is not limited to the same magnification as long as the operator can check a developing defect, and the operator may be allowed to set the magnification. For example, as in the example illustrated in FIG. **8**F, in a case where a crack **803** including a developing portion does not fit in the rectangular region outlined by an outer frame **835**, the display magnification may be changed such that the entire defect fits in the rectangular region as in the example illustrated in FIG. **8**G. In this case, a UI, such as a zoom button **871**, may be used to allow the operator to change the display magnification with which the defect can be checked. As in the example illustrated in FIG. **8**H, display may be changed in such a manner that the crack **803** is rotated by a desired angle, such as **90** degrees, to thereby display the crack **803** entirely within the rectangular region at the same magnification. As in the example illustrated in FIG. **8**I, the position of display may be changed in the vertical direction such that the developing portion of the crack **803** is displayed within the rectangular region at the same magnification.

[0075] Next, in S**704**, the CPU **101** determines whether the process has been performed for all processing target IDs. If the process has been performed for all IDs (Yes), the CPU **101** ends the process in the flowchart in FIG. **7**. If another ID for which the process is to be performed is present (No), the process returns to S**702**, and the CPU **101** changes the processing target to the next ID.

[0076] As described above, in this embodiment, the information processing apparatus **100** calculates the degrees of development of defects detected from two images captured at different times, specifies regions that cover the defects on the basis of the display resolution, and displays the regions of the defects in accordance with the degrees of development. Accordingly, the information processing apparatus **100** according to this embodiment can display a defect that has a high degree of development and that is to be preferentially checked among a large number of defects in accordance with the degree of development, at a resolution with which the operator can check the defect.

[0077] In this embodiment, although the process for obtaining defect data of the first input image in S**401** is an example process of using data of defects detected in the past, for example, defect data may be detected again on the basis of a newly set current reference. For example, there may be a case where the performance of a processing algorithm for detecting defects becomes higher than that at the time when the first defect data, which is past processing data, was generated and it becomes possible to detect a larger number of defects than in the first defect data in the past. In such a case, when the new processing algorithm is used to detect defect data, defects that were unable to be detected at the time when the first input image was captured can be compared with the current second defects, and developing defects can be grasped more accurately. In the process for obtaining defect data of the second input image in S**402**, defect data detected in advance may be used as input data.

[0078] In this embodiment, the first input image and the second input image are images that have been aligned with each other on the drawing, and a process for alignment between the images is not necessary. Therefore, when differences are simply calculated, aging data can be generated. On the other hand, for example, in a case where the first input image and the second input image are not aligned with each other, the process for alignment between the images may be performed, the differences between the images may be calculated, and aging data may be generated. In the process for alignment in this example case, an existing technique may be used. For example, the information processing apparatus may calculate feature points from each of the images and perform alignment on the basis of corresponding feature points. For example, the operator may manually specify corresponding points in the images and perform alignment.

[0079] In this embodiment, although the degrees of development are calculated on the basis of the differences between the first defect data and the second defect data, the information processing apparatus may calculate the degrees of development by further using third defect data captured at a different time and calculating the differences. When the differences between three or more pieces of defect data are used, the degrees of development that indicate accelerations can be calculated. The values of coefficients by which the values of degrees of development indicating accelerations are respectively multiplied may be changed. For example, in a case where a degree of development is high, the value of a corresponding coefficient in the flowchart in FIG. **6** is increased (made larger) to thereby increase the priority level. Accordingly, the operator can preferentially check the defect.

[0080] In this embodiment, although an example where the priority level is calculated on the basis of the degree of development of a defect has been described, for example, the priority level may be calculated by further using information indicating attributes of the structure. For example, regarding the slab of a bridge, an item on which the operator responsible for investigation and inspection places importance differs between the region of a portion near a bridge pier and the region of a middle portion between bridge piers even if the degrees of development of cracks are the same. Therefore, the information processing apparatus changes the values of coefficients used in calculation of the priority level by using, for example, information about the region of the portion near a bridge pier and information about the region of the middle portion between bridge piers as information indicating attributes of the structure. Similarly, an item on which the operator places importance differs between an upper portion and a lower portion of a bridge pier, and therefore, the information processing apparatus may change the values of coefficients to be used in priority level calculation, by using information about the upper portion and the lower portion as attribute information of the structure.

[0081] In this embodiment, an example where defects develop over time has been described. In a case where a defect has been repaired during the period from capturing of the first input image to capturing of the second input image, the line of a crack detected as a difference may become shorter or the area may be reduced. In this case, although the amount of difference has a negative value, the amount of difference may be assumed to be zero because the defect has not developed, and the defect may be excluded from display targets.

[0082] In the description of this embodiment, although processes that are performed by the CPU **101** of the information processing apparatus **100** have been described as steps in the flowchart in FIG. **4**, the processes in the respective steps can be represented by a functional block diagram including functions that are implemented by the CPU **101**. The functions of functional blocks may be substantially the same as the steps in FIG. **4**, and therefore, illustrations and descriptions thereof are omitted.

First Modification of First Embodiment

[0083] In the priority level calculation process according to the first embodiment, the priority level is calculated by multiplication by predetermined coefficients. In a first modification of the first embodiment, an example will be described where the operator responsible for inspection and investigation is allowed to change via a UI the priority level calculation reference (calculation rule) to thereby make the order in which the regions are presented to the operator changeable.

[0084] FIG. **10**A is a diagram illustrating an example of a UI screen **1000** that is presented to the operator responsible for investigation and inspection, who is a user. The UI screen **1000** allows the operator to select an item on which the operator places importance when the priority level is calculated, and includes radio buttons **1010** and important items **1021** to **1024**. Each of the radio buttons **1010** is a button that is selected when the operator selects a corresponding one of the important items **1021** to **1024**. The important items **1021** to **1024** that can be selected by using the radio buttons **1010** respectively correspond to the coefficients A to D described with reference to the flowchart in FIG. **6**. In the first modification of the first embodiment, the value of a coefficient corresponding to an important item selected by using the radio button **1010** is relatively made higher, and the values of coefficients corresponding to items not selected are relatively made lower.

[0085] The UI screen on which the priority level calculation reference (priority level calculation rule) can be changed in the first modification of the first embodiment has been described above. Accordingly, the operator can change the priority level calculation rules and can change an item on which the operator wants to place importance.

Second Modification of First Embodiment

[0086] In the first modification of the first embodiment, an example of the UI screen **1000** including radio buttons has been described. In a second modification of the first embodiment, an example UI via which the priority ranks of important items are changed will be described.

[0087] FIG. **10**B is a diagram illustrating an example of a UI screen **1050** according to the second modification of the first embodiment. The UI screen **1050** includes priority ranks **1061** to **1064** and important items **1071** to **1074**. On the UI screen **1050**, for the priority ranks **1061** to **1064**, the important items **1071** to **1074** are selected, and the items can be replaced or changed accordingly. On the basis of the changed priority ranks, the intensities of the values of coefficients for the important items or the magnitudes of the values are changed. In the example illustrated in FIG. **10**B, the coefficient B for the line width is assigned the first priority rank, the coefficient D for the area is assigned the second priority rank, the coefficient C for the intersection points is assigned the third priority rank, and the coefficient A for the line length is assigned the fourth priority rank. In this case, the information processing apparatus sets the magnitudes of the values set for the respective coefficients such that coefficient B>coefficient D>coefficient C>coefficient A holds.

[0088] Accordingly, the priority level can be changed in accordance with the operator's intention.

Third Modification of First Embodiment

[0089] In the first and second modifications of the first embodiment, the operator checks (visually checks) the screen showing developing defects from region to region. In a third modification of the first embodiment, an example will be described where a developing defect is displayed at a display resolution with which the operator can visually check (can check) the defect and the overall image is also displayed.

[0090] FIG. **11**A illustrates an example of a check screen **1101**. On the check screen **1101**, a region the same as that displayed on the check screen **951** illustrated in FIG. **9**B is displayed and a reduced image **1111** is further displayed in FIG. **11**A. In the reduced image **1111**, a rectangular region **1121** displayed on the check screen **1101** and a rectangular region **1131** displayed on a check screen **1151** illustrated in FIG. **11**B described below are displayed. The rectangular region **1121** corresponds to the region outlined by the outer frame **831** illustrated in FIG. **8**A of the first embodiment, and the rectangular region **1131** corresponds to the region outlined by the outer frame **833** illustrated in FIG. **8**A of the first embodiment. In FIG. **11**A, the rectangular region **1121** is highlighted and displayed. Similarly, on the check screen **1151** illustrated in FIG. **11**B, when the rectangular region **1131** is displayed on the display unit **105**, the rectangular region **1131** is highlighted and displayed.

[0091] In the description of FIG. **11**A and FIG. **11**B, although an example where two rectangular regions are displayed in the reduced image **1111** has been described, a plurality of rectangular regions, namely, three or more rectangular regions, including developing defects may be displayed. When the operator responsible for investigation and inspection performs a selection operation of, for example, clicking a region to be checked next on the reduced image **1111**, the selected region may be specified. The information processing apparatus may change the method for presenting regions to be checked by the operator, by changing the color, the color intensity, or the color saturation of the outer frame of each of the rectangular regions in order of priority level.

[0092] As described above, according to the third modification of the first embodiment, a region to be checked can be selected as desired in accordance with the operator's intention and, for example, the operator can check a region having a high priority level and can simultaneously check the region of a defect having a low priority level around the region having a high priority level.

[0093] Instead of displaying a reduced image, a method may be employed in which display in a list form in which items are arranged in order of priority level as illustrated as a list **1175** on the check screen **1171** in FIG. **11**C is performed to allow an item to be selected.

Fourth Modification of First Embodiment

[0094] In the first, second, and third modifications of the first embodiment, the coefficient is changed in accordance with whether the amount of development in a defect is the amount of increase in the line length or the amount of increase in the line width of a crack, or the amount of increase in the area of an exposed reinforcing rod, as illustrated in the flowchart in FIG. **6** to thereby calculate the priority level. In a fourth modification of the first embodiment, an example where the priority level is calculated on the basis of the rate at which a defect develops (degree of development or development rate) will be described.

[0095] FIG. **12**A and FIG. **12**B are diagrams illustrating example cracks present on the same examination target image. A crack **1200** illustrated in FIG. **12**A and a crack **1250** illustrated in FIG. **12**B are example cracks present on the same examination target image and represent the second defect data. The crack **1200** illustrated in FIG. **12**A is formed of, for example, a new crack portion **1211** (dotted line) having a length of 4 mm and an existing crack portion **1212** (solid line) having a length of 10 mm. The crack **1250** illustrated in FIG. **12**B is formed of, for example, a new crack portion **1261** (dotted line) having a length of 4 mm and an existing crack portion **1262** (solid line) having a length of 5 mm. Although the line length of the new crack portion of the crack **1200** and the line length of the new crack portion of the crack **1250** are the same, the proportion of the new crack portion to the crack **1200** is about 29% (=4/14), and the proportion of the new crack portion to the crack **1250** is about 44% (=4/9). In this case, the crack **1250** illustrated in FIG. **12**B in which the proportion of the developing crack is high has a higher degree of development (development rate), and therefore, the information processing apparatus changes a coefficient for the crack having a higher degree of development (development rate) to increase the priority level.

[0096] As described above, in the fourth modification, in a case where the amounts of development of defects (in the above example, the line lengths of the new crack portions) are the same but the degrees of development of the defects are different, an index for priority level calculation is changed on the basis of the degree of development.

[0097] In the above example, although an example of a line segment length has been described, the information processing apparatus may calculate the degree of development (development rate) of a defect by using the difference value between an existing width and a developing width, the difference value between an existing area and a developing area, or other difference values. Instead of using the degree of development (proportion or rate) of a single defect, a plurality of degrees of development may be used. A combination of the amount of development of a defect and the degree of development of the defect may be used.

Second Embodiment

[0098] In the first embodiment, a configuration has been described in which a screen showing developing defects is displayed and one operator responsible for investigation and inspection performs checking (visual checking) from region to region. In a second embodiment, an example configuration in which information about developing defects is stored on a server and distributed to a plurality of information processing apparatuses that are client terminals to thereby allow a plurality of operators to perform a check process will be described.

[0099] FIG. **13** is a diagram illustrating an example system configuration according to the second embodiment. The system configuration illustrated in FIG. **13** is constituted by a server **1301** and a plurality of information processing apparatuses **1311** to **1313**, which are connected to each other via, for example, a network **1305** so as to enable communication. Although FIG. **13** illustrates an example where the number of information processing apparatuses is three, the number is not limited to three. It is assumed that the hardware configuration of the server **1301** and that of the information processing apparatuses **1311** to **1313** are the same as the hardware configuration described with reference to FIG. **1**.

[0100] FIG. **14** is a flowchart illustrating a flow of information processing in the server **1301**. A process the same as that performed by the information processing apparatus **100** according to the first embodiment is assigned the same reference numeral, and a description thereof is omitted.

[0101] In S**1401**, the CPU **101** of the server **1301** divides the region table **901**, as illustrated in FIG. **9**A, specified and generated in S**405**, in accordance with the number of information processing apparatuses and distributes the divided tables to the information processing apparatuses via the communication unit **107**. When the region table **901** is divided, region IDs in the region table **901** are separated in accordance with the number of information processing apparatuses. For example, in a case where the number of information processing apparatuses that are client terminals is three as illustrated in FIG. **13** and the number of region IDs in the region table **901** is 90, the CPU **101** of the server **1301** divides the region table **901** into three tables each including 30 region IDs. The server **1301** transmits a region table including 30 region IDs to the information processing apparatus **1311**, a region table including the subsequent 30 region IDs to the information processing apparatus **1312**, and a region table including the remaining 30 region IDs to the information processing apparatus **1313**.

[0102] FIG. **15** is a flowchart illustrating a flow of information processing in the information processing apparatus **1311**. Similar information processing is performed also in the information processing apparatuses **1312** and **1313**.

[0103] In S**1501**, the CPU **101** of the information processing apparatus **1311** obtains information about the region table transmitted from the server **1301** via the communication unit **107**.

[0104] Next, in S**1502**, the CPU **101** of the information processing apparatus **1311** displays check target regions as in S**406** in FIG. **4** on the basis of the region table obtained in S**1501**. Accordingly, the operator using the information processing apparatus **1311** can perform checking.

[0105] In the second embodiment, the processes performed within the information processing apparatus in the first embodiment are separated and performed by the server and the client terminals. Therefore, according to the second embodiment, a large number of regions of developing defects can be checked separately by a plurality of operators responsible for investigation and inspection, and the time taken for the check operation can be reduced.

[0106] Regarding the method for registering the first defect data and the second defect data on the server, registration may be performed in the server or may be performed from any of the client terminals to the server.

[0107] Although an example has been described where in S**1401**, the region table is simply divided equally into tables each including a predetermined number of region IDs, allocation at the time of division may be changed in accordance with the priority levels of developing defects. For example, in a case where the level of skill differs among the operators responsible for investigation and inspection, an operator having a high level of skill may be assigned the region ID of a region including a defect having a high priority level, and an operator having a low level of skill may be assigned the region ID of a region including a defect having a low priority level. Accordingly, operators responsible for investigation and inspection having different levels of skill can be assigned in accordance with the priority levels, and developing defects can be checked efficiently.

[0108] As described above, the information processing apparatus according to the first and second embodiments can calculate the priority levels in accordance with the degrees of importance of developing defects and change the method for displaying regions that include developing defects. That is, the information processing apparatus according to the first and second embodiments calculates the priority levels of regions that include developing defects and changes a region including a defect to be displayed on the basis of the calculated priority levels. Accordingly, the operator responsible for investigation and inspection can efficiently inspect (check) a defect to be preferentially checked.

[0109] Some embodiments can be implemented as a process in which a program that implements one or more functions of the above-described embodiments is supplied to a system or an apparatus via a network or a storage medium and one or more processors of a computer in the system or the apparatus reads and executes the program. Some embodiments can be also implemented as a circuit (for example, an application-specific integrated circuit (ASIC)) that implements one or more functions.

[0110] Any of the above-described embodiments is a specific example for implementing the present disclosure and should not be used to construe the technical scope of the present disclosure in a limited manner.

[0111] That is, the present disclosure can be implemented in various forms without departing from the technical spirit or major features thereof.

[0112] According to the present disclosure, the possibility of the operator overlooking a defect that is to be checked can be reduced.

Other Embodiments

[0113] Some embodiment(s) can also be realized by a computer of a system or apparatus that reads out and executes computer-executable instructions (e.g., one or more programs) recorded on a storage medium (which may also be referred to more fully as a 'non-transitory computer-readable storage medium') to perform the functions of one or more of the above-described embodiment(s) and/or that includes one or more circuits (e.g., application specific integrated circuit (ASIC)) for performing the functions of one or more of the above-described embodiment(s), and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the computer-executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s) and/or controlling the one or more circuits to perform the functions of one or more of the above-described embodiment(s). The computer may comprise one or more processors (e.g., central processing unit (CPU), micro processing unit (MPU)) and may include a network of separate computers or separate processors to read out and execute the computer-executable instructions. The computer-executable instructions may be provided to the computer, for example, from a network or the storage medium. The storage medium may include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD)™), a flash memory device, a memory card, and the like.

[0114] While the present disclosure has described exemplary embodiments, it is to be understood that some embodiments are not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

What is claimed is:

1. An information processing apparatus comprising:
one or more memories storing instructions; and
one or more processors executing the instructions to:
obtain pieces of defect data included in a structure and respectively extracted from a plurality of images captured at different times;
detect a plurality of developing defects on a basis of differences between the pieces of defect data extracted from the captured images;
determine degrees of development of the plurality of developing defects on the basis of the differences between the pieces of defect data;
calculate priority levels on the basis of the degrees of development of the plurality of developing defects;
specify a plurality of regions in each of which at least one of the plurality of developing defects is included;
accept an operation by a user; and
perform control to display one image indicating one of the plurality of specified regions in an order according to the priority levels or display a plurality of images indicating the plurality of specified regions,
wherein in a case where a predetermined operation by the user is accepted in a state where a first image indicating a first specified region including a first priority level developing defect is displayed, the first image is erased and a second image indicating a second specified region including a second priority level developing defect having a lower priority level than the priority level of the first priority level developing defects is displayed, and
wherein in a case where the predetermined operation by the user is accepted in a state where a third image indicating a third specified region including a third priority level developing defect and a fourth image indicating a fourth specified region including a fourth priority level developing defect having a lower priority level than the priority level of the third priority level developing defects is displayed and the third image is highlighted, the third image becomes not highlighted and the fourth image becomes highlighted.

2. The information processing apparatus according to claim **1**, wherein the one or more processors further execute the instructions to perform control to cause another apparatus connected with the information processing apparatus to display the plurality of specified regions.

3. The information processing apparatus according to claim **2**, wherein
the another apparatus includes two or more second apparatuses, and
the one or more processors further execute the instructions to separate the plurality of specified regions into groups of regions each corresponding to a different one of the two or more second apparatuses and distribute each of the groups of regions to a corresponding one of the two or more second apparatuses.

4. The information processing apparatus according to claim **1**, wherein
the one or more processors further execute the instructions to specify the plurality of specified regions on a basis of a display resolution with which an operator is able to visually check the plurality of developing defects.

5. The information processing apparatus according to claim **1**, wherein
the one or more processors further execute the instructions to make a calculation reference for the degrees of development differ in accordance with types of the pieces of defect data extracted from the captured images.

6. The information processing apparatus according to claim **1**, wherein
the one or more processors further execute the instructions to change a calculation reference for the degrees of development on a basis of an instruction from a user.

7. The information processing apparatus according to claim **1**, wherein
the one or more processors further execute the instructions to display a user interface via which a user can change the order according to the priority levels.

8. The information processing apparatus according to claim **1**, wherein
the one or more processors further execute the instructions to superimpose and display each of the pieces of defect data on an image.

9. The information processing apparatus according to claim **1**, wherein
the one or more processors further execute the instructions to calculate the priority levels on a basis of information indicating an attribute of the structure.

10. The information processing apparatus according to claim **1**, wherein, in a case where a defect is determined not to have developed on the basis of the differences between the pieces of defect data, an undeveloped defect is not displayed.

11. The information processing apparatus according to claim **1**, wherein the image indicating the specified region is an outer frame.

12. The information processing apparatus according to claim **1**, wherein in the case where the predetermined operation by the user is accepted in the state where the third image and the fourth image is displayed and the third image is highlighted, at least one of color, color intensity and color saturation of the third image and the fourth image is changed.

13. The information processing apparatus according to claim **1**, wherein the one or more processors execute the instructions to calculate the priority levels on the basis of at least one of an amount of change in line length, an amount of change in line width, an amount of change in area, and an amount of change in intersection points.

14. An information processing method to be performed by an information processing apparatus, the information processing method comprising:

obtaining pieces of defect data included in a structure and respectively extracted from a plurality of images captured at different times;

detecting a plurality of developing defects on a basis of differences between the pieces of defect data extracted from the captured images;

of determining degrees of development of the plurality of developing defects on the basis of the differences between the pieces of defect data;

calculating priority levels on the basis of the degrees of development of the plurality of developing defects;

specifying a plurality of regions in each of which at least one of the plurality of developing defects is included;

accepting an operation by a user; and

displaying one image indicating one of the plurality of specified regions in an order according to the priority levels or displaying a plurality of images indicating the plurality of specified regions,

wherein in a case where a predetermined operation by the user is accepted in a state where a first image indicating a first specified region including a first priority level developing defect is displayed, the first image is erased and a second image indicating a second specified region including a second priority level developing defect having a lower priority level than the priority level of the first priority level developing defects is displayed, and

wherein in a case where the predetermined operation by the user is accepted in a state where a third image indicating a third specified region including a third priority level developing defect and a fourth image indicating a fourth specified region including a fourth priority level developing defect having a lower priority level than the priority level of the third priority level developing defects is displayed and the third image is highlighted, the third image becomes not highlighted and the fourth image becomes highlighted.

15. A non-transitory computer-readable storage medium storing a program for causing a computer to execute an information processing method, the information processing method comprising:

obtaining pieces of defect data included in a structure and respectively extracted from a plurality of images captured at different times;

detecting a plurality of developing defects on a basis of differences between the pieces of defect data extracted from the captured images;

determining degrees of development of the plurality of developing defects on the basis of the differences between the pieces of defect data;

calculating priority levels on the basis of the degrees of development of the plurality of developing defects;

specifying a plurality of regions in each of which at least one of the plurality of developing defects is included;

accepting an operation by a user; and

displaying one image indicating one of the plurality of specified regions in an order according to the priority levels or displaying a plurality of images indicating the plurality of specified regions,

wherein in a case where a predetermined operation by the user is accepted in a state where a first image indicating a first specified region including a first priority level developing defect is displayed, the first image is erased and a second image indicating a second specified region including a second priority level developing defect having a lower priority level than the priority level of the first priority level developing defects is displayed, and

wherein in a case where the predetermined operation by the user is accepted in a state where a third image indicating a third specified region including a third priority level developing defect and a fourth image indicating a fourth specified region including a fourth priority level developing defect having a lower priority level than the priority level of the third priority level developing defects is displayed and the third image is highlighted, the third image becomes not highlighted and the fourth image becomes highlighted.

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