MAP CHECKUP APPARATUS, CHECKUP METHOD AND CHECKUP PROGRAM

TECHNICAL FIELD

[0001] The present disclosure relates to technologies that examine a pickup result of an individual chip from a wafer attached on a dicing sheet.

BACKGROUND ART

[0002] In semiconductor manufacturing processes, a mounting process and a die bonding process are carried out after a wafer attaching process and a dicing process. The wafer attaching process is a process of attaching a wafer before cut into individual chips to a dicing sheet that has an adhesive surface, and this dicing sheet is attached on a ring.

[0003] The dicing process is a process of cutting the wafer attached on the dicing sheet, thereby dividing the wafer into individual semiconductor elements (hereinafter, referred to as "chips"). The mounting process is a process of sequentially picking up individual chips, and bonding the picked-up chip on a lead frame or a substrate. The die bonding process is a process of joining a lead and the chip using a gold wire, etc.

[0004] A probe inspection that inspects the electrical characteristics through a contact needle is performed beforehand for each chip contained in the wafer prior to the mounting process, and information on the inspection results, such as non-defectiveness, defectiveness, and position of each chip, is stored in a control device. Information obtained through such a probe inspection is called map data.

[0005] In addition, a visual inspection based on an image obtained by an imaging unit like a camera is sometimes performed for each chip before the pickup operation. When the visual inspection is performed in addition to the probe inspection, the combination of the probe inspection result

and the visual inspection result is also called map data in some cases.

[0006] Still further, the pickup operation in the mounting process is performed on the chip determined as a non-defective product upon the probe inspection result (including the result of the visual inspection in some cases). This is because to prevent a defective chip from being delivered as a product.

RELATED TECHNICAL DOCUMENTS

PATENT DOCUMENT

[0007] Patent Document 1: JP 2011-61069 A

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0008] The chips contained in the wafer are extremely scaled down, and thus an error may occur in the pickup operation. In this case, the most serious problem is that a map displacement occurs which displaces the position where the chip is actually picked up from the positional information of the chip on the map data due to a pickup error, and the following chips are picked up at displaced positions, causing a defective product to be delivered as a non-defective product.

[0009] Hence, it is necessary to examine whether or not a defective product has been picked up, and to take a countermeasure like deactivation of an apparatus when a defective product has been delivered. An example examination scheme is to superimpose a sheet of a copied image of chips remaining in the dicing sheet after the pickup operation with a sheet of a copied image based on the positions of non-defective product and those of defective product in the map data that are the inspection result, and to check those sheets with each other visually.

[0010] However, such an examination scheme has the following problems. First, as premises, the individual

chips having undergone the dicing are intimately contacting one another substantially without a gap with the adjoining chips. Hence, after the dicing, the dicing sheet is expanded before the pickup operation so as to facilitate the pickup operation, thereby forming a gap between the individual chips.

[0011] Hence, when the visual checkup is performed, an image of remaining chips in the dicing sheet after the dicing sheet having undergone the pickup operation is taken out from the ring, and the expanded condition is canceled, and, this image is utilized for a checkup with an image based on map data.

[0012] However, the expanded dicing sheet and the dicing sheet released from the expanded condition have partial distortions. Hence, there may be a partial displacement between the position of the chip in the image of the dicing sheet having undergone the pickup operation and the position of the chip in the image based on the map data. Therefore, according to the above-explained checkup scheme, there is a possibility that precise examination is difficult in some cases. In addition, since the checkup is performed visually, there may be an oversight.

[0013] Still further, since the visual checkup is performed with the dicing sheet being removed from the ring and being released from the expanded condition, it is necessary to perform the visual checkup in an off-line condition out from the apparatus. Therefore, this checkup scheme needs a labor work and a time, causing the reduction of the productivity.

[0014] Patent Document 1 proposes a technology of detecting dicing grooves caused by the expansion of the dicing sheet, determining the presence of the chips or absence thereof, and performing a checkup in consideration of the gap between the chips. However, the contrast between the chip and the dicing sheet is relatively clear, but it is not easy to precisely determine, through the image, the microscopic dicing grooves formed on the dicing sheet.

[0015] Moreover, the expansion amount of the expanded dicing sheet and the expansion direction thereof vary depending on the position of the dicing sheet and the presence of the chips or absences thereof. Hence, a partial distortion is caused in the dicing groove and the position of the chip, making a precise examination difficult.

[0016] The present disclosure has been proposed to address the above-explained technical problems of conventional technologies, and it is an objective of the present disclosure to provide a map checkup apparatus, a checkup method and a checkup program which can specify the position of a chip at a fast speed based on a feature of the chip only, and which can examine the pickup condition of the chip precisely and at a fast speed even if a dicing sheet contains a partial distortion by performing a calculation in consideration of the displacement direction of the chip and the displacement amount thereof due to an expansion of the dicing sheet.

SOLUTION TO PROBLEM

[0017] To accomplish the above objective, a map checkup apparatus according to the present disclosure includes: a displacement calculator calculating a displacement direction of a chip and a displacement amount thereof due to an expansion of a dicing sheet based on synthesis image data to create an image of the dicing sheet having undergone a pickup of a chip that is a piece of a wafer, and having undergone the expansion of the dicing sheet on which the wafer having undergone dicing is attached, and map image data to create an image representing a position of a chip to be picked up or not to be picked up; a corrector correcting at least either one of the synthesis image data and the map image data based on the displacement direction and the displacement amount both calculated by the displacement calculator; and a determiner checking, between the synthesis image data and the map image data, the corrected data with the not-corrected

data, and determining consistency or inconsistency therebetween.

[0018] The displacement calculator may divide the wafer on the dicing sheet into a plurality of areas, and calculate, for each area, the displacement direction and the displacement amount.

The synthesis image data may be image data based on the dicing sheet expanded by force in a direction from an internal side of a circle that encircles the wafer to an external side thereof.

[0019] The map checkup apparatus may further include, in order to enable the displacement calculator to perform calculation, a feature extractor extracting a feature point of each chip based on the synthesis image data and the map image data.

The map checkup apparatus may further include a synthesis-image creator creating, based on image data obtained in association with a pickup of each chip, the synthesis image data.

[0020] The map checkup apparatus may further include an inspector performing a visual inspection on each chip based on image data obtained in association with a pickup of each chip.

The map checkup apparatus may further include, a map-image creator creating the map image data based on map data that contains information on at least either one of a non-defective chip in the wafer and a position of the non-defective chip, and, a defective chip in the wafer and a position of the defective chip.

The corrector may correct the synthesis image data.

[0021] The map checkup apparatus may further include a display-data creator creating display data to display, on a display, a determination result by the determiner.

The display data may be image data that distinguishably displays a consistent part or inconsistent

part between the synthesis image data and the map image data for the chip on the dicing sheet.

The display data may be image data that distinguishably displays a part where the chip not to be picked up has been picked up on the dicing sheet.

[0022] The feature point may be a corner of each chip.

The displacement direction of any one of the plurality of areas and the displacement amount thereof are calculated based on the displacement directions and the displacement amounts of the other areas.

The map checkup apparatus may further include an analyzer determining a tendency of a pickup result by analyzing a determination result by the determiner.

[0023] A method of executing, through a computer or an electronic circuit, the functions of the respective units, and a program that causes a computer to execute the same are also aspects of the present disclosure.

ADVANTAGEOUS EFFECTS OF INVENTION

[0024] According to the present disclosure, a map checkup apparatus, a checkup method and a checkup program can be provided which can specify the position of a chip at a fast speed based on a feature of the chip only, and which can examine the pickup condition of the chip precisely and at a fast speed even if a dicing sheet contains a partial distortion by performing a calculation in consideration of the displacement direction of the chip and the displacement amount thereof due to an expansion of the dicing sheet.

BRIEF DESCRIPTION OF DRAWINGS

[0025] FIG. 1 is a simplified side view illustrating a structure of a pickup device according to an embodiment of the present disclosure;

FIG. 2 is a plan view illustrating a structure of a ring and a dicing sheet attached thereon according to the embodiment of the present disclosure;

FIG. 3 is a block diagram illustrating a structure of a map checkup apparatus according to the embodiment of the present disclosure;

FIG. 4 is a block diagram illustrating a structure of a checkup unit in FIG. 3;

FIGS. 5A to 5C are explanatory diagrams illustrating an outline of a map checkup function;

FIGS. 6A and 6B are explanatory diagrams illustrating a map image based on map image data created from map data;

FIG. 7 is a flowchart illustrating a process procedure of the map checkup apparatus according to the embodiment of the present disclosure;

FIG. 8 is a flowchart illustrating a procedure of a checkup process in FIG. 7;

FIG. 9 is an explanatory diagram illustrating a captured image after a pickup operation and a synthesis image;

FIGS. 10A to 10C are explanatory diagrams illustrating a feature-point extracting process;

FIGS. 11A to 11D are explanatory diagrams illustrating a corner-direction detecting process;

FIGS. 12A and 12B are explanatory diagrams illustrating detected feature points;

FIGS. 13A to 13C are explanatory diagrams illustrating a result of a calculating process of a vector representing a displacement direction and a displacement amount;

FIGS. 14A and 14B are explanatory diagrams illustrating a difference image between a synthesis image and a map image; and

FIGS. 15A and 15B are explanatory diagrams illustrating how a checkup result is displayed.

DESCRIPTION OF EMBODIMENTS

[0026] An explanation will be given of an embodiment of the present disclosure with reference to the accompanying figures.

Various data utilized in the embodiment and images created based on the same are as follows.

(1) "Map data" that is information relating to at least either one of the non-defective chip and position of the chip, or, the defective chip and position of the chip. Note that this information includes chip information on a non-product chip, such as a reference chip or a chip on a ring. This map data contains reference map data and device management map data.

(2) "Reference map data" that is data relating to a distribution of non-defective products and that of defective products (positions on a wafer) which are a result of a probe inspection performed beforehand in a pre-preparation process.

(3) "Device management map data" that is data obtained by combining the "reference map data" with data relating to a distribution of non-defective products and that of defective products which are a result of a visual inspection, and further with data relating to whether or not each chip has been picked up.

(4) "Map image data" that is data to display a map image on a screen. The "map image" is an image of a chip on the dicing sheet which should not be picked up. The "map image data" is created based on the device management map data in the map checkup apparatus, and is utilized for a checkup process with synthesis image data.

(5) "Synthesis image data" that is data to display a synthesis image on the screen. The "synthesis image" is an image of a chip on the dicing sheet having undergone the pickup operation. The "synthesis image data" is created by synthesizing pieces of image data obtained by an imaging unit, and is utilized for the checkup process with map image data.

[0027] [1. Pickup Device]

First, an example pickup device 1 according to this embodiment will be explained with reference to FIG. 1 and FIG. 2. This embodiment is applicable to mechanisms in various

forms, and the mechanism explained below is merely an example. Hence, the explanation will be simplified.

[0028] As illustrated in FIG. 1, this pickup device 1 includes a ring moving mechanism 2, an expand mechanism 3, a separating mechanism 4, a pickup mechanism 5, and an imaging mechanism 6. The ring moving mechanism 2 is a device that moves a wafer ring R attached to a ring holder 21 in a predetermined direction.

[0029] As illustrated in FIG. 2, the wafer ring R is a plate member that holds a attached dicing sheet D thereon so as to cover a circular opening formed inwardly. A wafer W is attached on this dicing sheet D. In addition, the wafer W is cut into plural chips S by dicing.

[0030] The ring moving mechanism 2 is installed so as to position the ring holder 21 in an X-axis direction and a Y-axis direction along unillustrated guide rails. In addition, the ring moving mechanism 2 is also installed so as to position the ring holder 21 in a θ direction by belts, pulleys, etc., which transmit drive force by an unillustrated motor.

[0031] The expand mechanism 3 is a mechanism that expands the dicing sheet D to form gaps among the individual chips. This expand mechanism 3 includes a cylindrical tensioner 31. The tensioner 31 employs the following structure to expand the dicing sheet D. First, one end of the cylindrical tensioner 31 is caused to abut the opposite side of the wafer W on the dicing sheet D to the wafer W attached surface from the back side of the wafer ring R. Next, the tensioner is moved so as to protrude toward the front face of the wafer ring R with the dicing sheet D being held between the outer circumference of the tensioner 31 and the inner circumference of the circular opening of the wafer ring R. This causes the dicing sheet D to expand by force in a direction from the internal side of a circle that encircles the wafer W to the external side thereof. In order to realize such an operation, the tensioner 31 can move forward or retract by a cylinder, etc.

[0032] The separating mechanism 4 is a device that separates individual chip S from the dicing sheet D. This separating mechanism 4 includes a pin 41 that faces the chip S across the dicing sheet D. This pin 41 is installed so as to move the chip S reaching the facing position together with the movement of the ring moving mechanism 2 in a depressing direction by a tip of the pin.

[0033] The pickup mechanism 5 receives the chip S separated from the other chips S by the separating mechanism 4, and passes the received chip to the other process. The pickup mechanism 5 includes an sucking nozzle 51 that performs vacuum chucking on the chip S. The sucking nozzle 51 is movable so as to pass the catching chip S to the other process.

[0034] The imaging mechanism 6 is a mechanism that obtains an image of the dicing sheet D and that of the chip S. The imaging mechanism 6 includes an imaging unit 61 and a prism 62. The imaging unit 61 is a camera that outputs obtained data. The prism 62 is an optical member that converts the direction of an optical axis so as to enable the imaging unit 61 to obtain the image of the chip S picked up by the sucking nozzle 51.

[0035] [2. Structure of Map Checkup Apparatus]

Next, a structure of a map checkup apparatus 100 connected with the above-explained pickup device 1 according to this embodiment will be explained with reference to the block diagrams of FIG. 3 and FIG. 4, and explanatory diagrams of FIG. 5 and FIG. 6. The map checkup apparatus 100 includes a mechanism control unit 101, an inspection unit 102, a synthesis-image creating unit 103, a map-image creating unit 104, a checkup unit 105, a display-data creating unit 106, and a memory unit 107. The mechanism control unit 101 is a process unit that controls the action of each mechanism of the above-explained pickup device 1.

[0036] The inspection unit 102 is a process unit that determines whether the chip S is a non-defective product or a defective product from the visuals based on image data of

the wafer having undergone dicing on the dicing sheet D. This image data is obtained by the imaging unit 61. The image obtainment and capturing by the imaging unit 61 is performed through a horizontal reciprocating scanning.

[0037] The horizontal reciprocating scanning in this case is a scheme of scanning on plural parallel scanning lines set from the one end of a circle located within the ring R that encircles the wafer W to the opposite end so as to cover the whole circle, and capturing images in both ways in reciprocation.

[0038] In this embodiment, the inspection unit 102 may perform a visual inspection on the pickup operation of each chip S by the pickup mechanism 5. That is, visual inspection is performed for each chip S right before the pickup operation of the individual chip S. The imaging unit 61 has a constant imaging range for each image obtainment, and thus the plural chips S around the chip S subjected to imaging are also within the imaging range for each image obtainment. Hence, when the image of the chip S to be picked up is obtained, the chip S to be picked up next is also within the imaging range. Accordingly, by performing a visual inspection on the chip S to be picked up next based on the obtained image, the visual inspection on the chip S before picked up can be performed together with the scanning for the pickup operation, and thus the process speed can be increased. In this embodiment, the imaging unit 61 has a fixed position, and the ring moving mechanism 2 moves the dicing sheet D to perform scanning. However, the imaging unit 61 may move to perform scanning. In addition, prior to the start of the pickup operation, the inspection unit 102 may perform a visual inspection beforehand on the whole wafer W.

[0039] A result of the visual inspection by the inspection unit 102 is stored as the device management map data in the memory unit 107 in association with the reference map data relating to the distribution of non-defective products and that of the defective products which are the result of the

probe inspection. The probe inspection is performed on the wafer W in the other process, and the reference map data that is the result of the probe inspection is stored beforehand in the memory unit 107.

[0040] The mechanism control unit 101 determines whether or not each chip S should be picked up by the pickup mechanism 5 based on the device management map data. This determination may be performed based on only the result of the probe inspection in the pre-preparation process, or when the visual inspection has been performed beforehand, the determination may be performed based on both of the result of the probe inspection and the result of the visual inspection.

Hence, the following chips S are removed from the target to be picked up.

(a) Chip S determined as the defective product through the probe inspection only.

(b) Chip S determined as the defective product through the visual inspection only.

(c) Chip S determined as the defective product through the probe inspection and the visual inspection.

(d) Chip S distinguished by a reference mark, etc., to indicate the position on the wafer, and not originally a product.

The visual inspection may be performed by the inspection unit 102 or in the other process beforehand on the wafer W before the start of the pickup operation, and data that is a result of the visual inspection may be stored as the map data in the memory unit 107 in association with the data that is the result of the probe inspection.

[0041] The synthesis-image creating unit 103 is a process unit that creates synthesis image data based on partial image data of the dicing sheet D having undergone the pickup operation of the chip S, and the partial image data is obtained and captured by the imaging unit 61. Prior to this image obtainment, the wafer attached on the dicing sheet D has already undergone dicing. In addition, the above-explained

expand mechanism 3 expands the dicing sheet D, and thus gaps are formed among the individual chips S so as to facilitate the pickup mechanism 5 to pick up the chip. This expansion is performed by the above-explained wafer ring R and tensioner 31. Hence, the expansion is performed by force that pulls the dicing sheet D from the internal side of the circle that encircles the wafer W to the external side.

[0042] The image obtainment by the imaging unit 61 to create the synthesis image data is performed through the horizontal reciprocating scanning like the above-explained visual inspection. The process of creating the synthesis image data in this case will be explained in more detail. First, as explained above, the imaging unit 61 has the constant imaging range for each image obtainment, and the plural chips S around the chip S subjected to imaging are also within the imaging range for each image obtainment. The moving width (pitch) in the scanning matches the position of each chip S after the expansion, and thus respective obtained images have sequential overlap. Hence, the overlap part is sequentially updated based on the latest obtained image, and images are synthesized to create a whole image.

[0043] The synthesis-image creating unit 103 synthesizes, as explained above, the pieces of image data sequentially captured through the horizontal reciprocating scanning, thereby creating the synthesis image data. The image obtainment and creation of the synthesis image data are performed through horizontal reciprocating scanning again after the completion of the pickup operation of the chip S from the dicing sheet D. However, as will be discussed later, the image obtainment and creation of synthesis image data may be performed in accordance with the pickup of each chip by the pickup mechanism 5. That is, the expression "after the pickup" means a time after the completion of the pickup operation for the entire wafer W and a time after each chip S is picked up.

[0044] Regardless of whether the image is obtained after the completion of the pickup operation for the entire wafer W or is obtained in accordance with the pickup of each chip, the synthesis image data to be eventually created is image data that enables identification of the chips S remaining in the dicing sheet D on the ring R. For example, as illustrated in FIG. 5A, the synthesis image displayed based on this synthesis image data indicates the remaining chips S with a black color.

[0045] The pickup operation by the pickup mechanism 5 has a possibility that the non-defective chip S is not successfully picked up, and the defective chip S is falsely picked up. In addition, when, due to the expansion of the dicing sheet D, the position of the chip S is displaced from the position of the pickup mechanism 5 which scans that chip S in accordance with the device management map data, the above-explained pickup errors may occur. Hence, the errors occur when the remaining chips include some non-defective products and when no defective product is left.

[0046] The map-image creating unit 104 is a process unit that creates the map image data based on the device management map data. The device management map data is data indicating whether or not each chip has been picked up based on information on the non-defective products and the defective products after the probe inspection, and also information on the non-defective products and the defective products when the visual inspection has been also performed. For example, the device management map data is recorded with information that enables distinction of the non-defective products and the defective products through the probe inspection, and the non-defective products, the defective products, the location outside the ring, the location on the ring, and the reference mark when the visual inspection has been also performed, and, information relating to whether or not each chip S has been picked up after the pickup operation. FIG. 6A illustrates

example device management map data, but the present disclosure is not limited to this expression form.

[0047] The map image data is image data of the chip not to be picked up and to be left. For example, the map-image creating unit 104 converts the above-explained device management map data into a form that facilitates visual distinction of the chips S and the like. Hence, as illustrated in FIG. 5B and FIG. 6B, the device management map data is converted into map image data to display a map image that expresses the chips S on the ring and the defective products with a black color, while the exterior of the ring with a gray color. Note that the device management map data in FIG. 6A is data not expressing the color and the tone, etc., to be displayed as those are. Hence, the color, the tone, etc., in FIG. 6B are not always consistent with the numerical values expressed in FIG. 6A.

[0048] The checkup unit 105 is a process unit that checks the synthesis image data with the map image data to determine the inconsistency. As illustrated in FIG. 4, the checkup unit 105 includes an adjuster 105a, a feature extractor 105b, a displacement calculator 105c, a corrector 105d, a checkup processor 105e, and a determiner 105f.

[0049] The adjuster 105a is a process unit that adjusts (resizes) the size of the synthesis image data and that of the map image data to the sizes suitable for checkup.

[0050] The feature extractor 105b is a process unit that extracts feature points of each chip S from the resized synthesis image data and map image data. The feature points are each, for example, a point indicting a corner of the chip S. The corners are the four corners of the chip S, i.e., the apexes of the edges defined by the contour of the rectangular chip S. Since each chip S has the four corners, there are four feature points for each chip S. The feature points can be extracted through a scheme to be discussed later, but the present disclosure is not limited to such a scheme, and all schemes available currently or in future are applicable.

[0051] The displacement calculator 105c is a process unit that calculates the displacement direction and displacement amount of each chip S based on the feature points extracted from the map image data and the synthesis image data. The feature points of each chip S in the map image data are displaced (shifted) from the feature points of the corresponding chip S in the synthesis image data due to the expansion of the dicing sheet D and the difference in the center position, etc.

[0052] This expansion is performed by the force directed from the internal side of the circle that encircles the wafer W to the external side as explained above. Hence, the displacement direction and displacement amount of the feature point varies depending on which position the feature point is located on the dicing sheet D. For example, depending on the position on the dicing sheet D, there is a part that has the displacement direction in the opposite direction or in the similar direction. Hence, it is meaningless to define the common displacement direction of the feature point for the entire wafer W.

[0053] Conversely, the displacement directions and displacement amounts of the respective feature points are common partially on the dicing sheet D. Hence, the dicing sheet D is divided into plural regions (areas), and the calculation by the displacement calculator 105c is performed for each area. For example, the displacement calculator 105c obtains, for each of the plural areas, a vector indicating a displacement direction and a displacement amount. This can be accomplished through a scheme to be discussed later, but the present disclosure is not limited to such a scheme, and all schemes available currently or in future are applicable.

[0054] The corrector 105d is a process unit that corrects the position of the feature point in the synthesis image data based on the displacement direction and the displacement amount both obtained by the displacement calculator 105c. This correction is to displace and return the position of the

feature point in each area by what corresponds to the displacement direction and displacement amount of each area explained above.

[0055] The corrector 105d may correct the map image data instead of the synthesis image data. However, the map image data created based on the device management map data precisely reflects the gaps among the chips S. Conversely, the synthesis image data contains the displacement of the position of the chip S due to the expansion of the dicing sheet D. Hence, according to this embodiment, the synthesis image data is corrected with reference to the map image data.

[0056] The checkup processor 105e is a process unit that checks the corrected synthesis image data with the map image data and creates a difference image. The creation process of this difference image is performed for each of the divided areas explained above in order to eliminate the adverse effect of the displacement. The determiner 105f is a process unit that determines the inconsistency of the feature point between the synthesis image and the map image based on the difference image created by the checkup processor 105e.

[0057] The memory unit 107 is a process unit that stores various kinds of information necessary to carry out this embodiment. The various kinds of information include the above-explained inspection results, the map data (reference map data, and device management map data) based on the same, captured image data, the synthesis image data, the map image data, a determination result, display data, and the like. In addition, various settings, such as a command, encoder information, a threshold, a determination criterion, a process timing, a calculation formula, an image adjustment value, are also contained in the information stored in the memory unit 107.

[0058] In addition, the map checkup apparatus 100 is connected with an input unit 30 and an output unit 40. The input unit 30 is a process unit that inputs necessary information for the process of each unit, and inputs a process

selection and an instruction. The input unit 30 includes all input devices available currently or in future, such as an operation panel, a touch panel, a switch, a keyboard, and a mouse.

[0059] The output unit 40 is a process unit which includes an interface for an operation, and which outputs various information including data, images, and process results. The output unit 40 includes all output devices available currently or in future, such as a display device and a printer.

[0060] All of or a part of the above-explained map checkup apparatus 100 can be realized by controlling a computer with a predetermined program. In this case, the program utilizes physical hardware resources of the computer like a CPU, thereby realizing the processes of the respective units explained above. The method of executing the processes of the respective units explained above, the program, and a non-transitory recording medium having stored therein the program are also aspects of the present disclosure.

[0061] The range processed by the hardware resources, and the range processed by software resources including the program can be set freely. For example, any one of the above-explained units may be constructed as a circuit that realizes the own process.

[0062] In addition, the memory 107 includes all memory media available currently or in future. A register, etc., for a calculation can be also understood as the memory unit. The ways of storing includes not only to hold data for a long time but also to temporarily store the data for a process and to eliminate or update the data within a short time. Still further, all of or a part of each process unit, the memory unit 107, the input unit 30, and the output unit 40 constructing the map checkup apparatus 100 can be realized by a computer connected through a network.

[0063] Various kinds of images created and to be created through the processes of the respective units explained above are image data before displayed on the output unit 40 when

those images are processed in the computer. Hence, before displayed on the output unit 40, those images are handled and processed as the image data in the computer.

[0064] However, the image data during the above-explained processes all can be output (e.g., display, printout) by the output unit 40 as needed, enabling an operator to check the image data visually. For example, the captured image, the synthesis image, the map image, a checkup result image, a feature-point extraction image, an image of the displacement calculation result, the difference image through the matching, and an image with eliminated noises, etc., may be displayed or printed out for the operator to check the process result.

[0065] [3. Action]

An example action according to the above-explained embodiment will be explained with reference to the flowcharts of FIG. 7 and FIG. 8, and the explanatory diagrams of FIG. 5, FIG. 6, FIG. 9 to FIG. 15. The wafer W attached on the dicing sheet D is subjected to a probe inspection beforehand, and the reference data that is the result of the probe inspection is stored in the memory unit 107. In addition, the mechanism control unit 101 actuates the expand mechanism 3 to expand the dicing sheet D, thereby expanding the gaps among the chips S beforehand.

[0066] [3-1. Process Outlines]

According to this embodiment, display data that enables the operator to check the consistency or inconsistency by a checkup of the synthesis image with the map image data is created. The synthesis image data is data to display, on the output unit 40, a synthesis image illustrated in, for example, FIG. 5A. The synthesis image data has the displacement due to the expansion of the dicing sheet D corrected by the corrector 105d. The map image data is data to display, on the output unit 40, a map image illustrated in, for example, FIG. 5B. The display data is data to display, on the output unit 40, a checkup result image illustrated in, for example, FIG. 5C.

[0067] [3-2. Process Details]

Next, the details of the above-explained processes will be explained with reference to the flowchart of FIG. 7. First, the mechanism control unit 101 waits for (step 101) a command "W" of the program that instructs the scanning of the wafer W, and encoder information X, Y. The encoder information X, Y are information to move the ring moving mechanism 2 in such a way that the sucking nozzle 51 scans and is positioned to each chip S after the expansion based on the device management map data that reflects the reference map data which is the result of the probe inspection.

[0068] The mechanism control unit 101 that has received the command "W" and the encoder information X, Y actuates (step 102) the ring moving mechanism 2, the separating mechanism 4, the pickup mechanism 5, and the imaging mechanism 6. That is, the mechanism control unit 101 actuates the ring moving mechanism 2 in such a way that the chip S to be picked up is positioned relative to the sucking nozzle 51. As explained above, the inspection unit 102 may cause the imaging unit 61 to obtain the image of the chip S right before the pickup operation, and may perform the visual inspection to determine whether the chip S is a non-defective product or a defective product based on the image obtainment result. In this case, the device management map data also reflects the result of the visual inspection. When the chip S is a non-defective product, the separating mechanism 4 pushes the target chip S through the pin 41, and separates this chip from the other chips S. The sucking nozzle 51 catches the separated chip S, and passes this chip to the other process. The above-explained processes are repeated (step 103: NO) from the first chip S in the wafer W to the last chip. The result of the visual inspection, the result of the presence of each picked-up chip S or absence thereof are stored in the memory unit 107 as the device management data in association with data relating to the distribution of non-defective products

and that of defective products which are the result of the probe inspection.

[0069] Through the above-explained procedures, the pickup operation (including the visual inspection in some cases) from a sheet of wafer W completes (step 103: YES). In this case, the mechanism control unit 101 actuates the ring moving mechanism 2, and returns the imaging position of the imaging unit 61 (position of sucking nozzle 51) to the header position of the first row to be scanned.

[0070] Next, the mechanism control unit 101 waits for (step 105) the command "W" that instructs the scanning of the wafer W, and the encoder information X, Y, after the ring moving mechanism 2 returns (step 104) to the header position of the first row to be scanned. When receiving the command "W", the mechanism control unit 101 actuates (step 106) the ring moving mechanism 2 and the imaging mechanism 6 based on the encoder information X, Y.

[0071] That is, the mechanism control unit 101 actuates the ring moving mechanism 2 in such a way that the imaging unit 61 performs the horizontal reciprocating scanning. The imaging unit 61 sequentially captures (step 107) pieces of image data at positions corresponding to the respective chips S.

[0072] Subsequently, the memory unit 107 sequentially stores (step 108) the pieces of captured image data so as to enable the synthesis-image creating unit 103 to attach the captured image data and to create the entire image data. For example, captured images (1) to (3) illustrated in FIG. 9 are images created based on partial captured image data obtained through the horizontal reciprocating scanning.

[0073] When, after the capturing of the partial image data, the capturing of all partial image data is not completed yet (step 109: NO), the mechanism control unit 101 executes the processes (steps 105 to 108) after the waiting status for the command.

[0074] When reaching the final position of the last row to be scanned, and imaging of all partial image data completes, the mechanism control unit 101 sets (step 109: YES) a complete flag.

[0075] The synthesis-image creating unit 103 attaches and synthesizes those pieces of captured image data, and adjusts those pieces of attached image data as the entire image data, thereby creating the synthesis image data. The synthesis-image creating unit stores (step 110) the created image data in the memory unit 107. In an example synthesis image based on the synthesis image data in FIG. 9, the black part indicates the remaining chips S on the ring or not picked up.

[0076] Conversely, the map-image creating unit 104 convers the above-explained device management map data (including the result of probe inspection and that of visual inspection) and creates (step 111) the map image data. FIG. 6B illustrates an example map image based on the map image data created in this way. In FIG. 6B, as explained above, the chips S that are on the ring or are the defective products are indicated with a black color, and the exterior of the ring is indicated with a gray color. This map image is, however, not an image actually obtained, and is a sort of virtual image created based on the map image data.

[0077] Next, the checkup unit 105 performs the checkup process (step 112) of the synthesis image data with the map image data. The details of this checkup process will be explained with reference to the flowchart of FIG. 8. First, the adjuster 105a resizes (step 201) the synthesis image data and the map image data so as to be suitable for checkup.

[0078] Next, the feature extractor 105b extracts (step 203) the feature points in the image of the chip S in the synthesis image data and in the map image data. According to this embodiment, the four corner points of the chip S are extracted. As to the extraction of the feature points, for example, the

following scheme is applied. This is one of the schemes which are capable of detecting corners in image data at a fast speed.

[0079] An example process by this scheme will be explained below. First, FIG. 10B illustrates an image that enlarges a corner illustrated in FIG. 10A. As illustrated in FIG. 10C, an annular filter including 1 to 16 pixels is set for FIG. 10B. Next, in the pixels of 1 to 16 constructing the filter, when the pixels brighter than a center pixel P of the filter are equal to or larger than 10 and the pixels darker than the center pixel P are equal to or larger than 4, the center pixel P is detected as a corner.

[0080] When the annular contour of the filter is cut because of darker pixels than the background, and becomes a substantially C shape, the direction of the corner can be detected based on such a cut-out position. For example, FIGS. 11A to 11D illustrate example cases in which the cut-out is formed at the lower right, the lower left, the upper right, and the upper left, respectively, but based on the position of such a cut-out, the direction can be detected.

[0081] FIG. 12B illustrates an example feature-point extraction image based on feature-point extraction image data extracted from the map image data. FIG. 12A is a map image based on the map image data. In FIG. 12B, the corner within the ring is also extracted as the feature point, and is displayed.

[0082] Next, the displacement calculator 105c calculates (step 204) the displacement direction and displacement amount of the feature point in the synthesis image based on the extracted feature points. This calculation is, as explained above, performed by dividing the image into the plural areas, and obtaining a vector for each area. The number of divided areas is not limited to a particular number, and can be set freely. When, however, the number of divided areas is large, it becomes possible to more precisely correct the displacement of each part. For example, it is desirable that the square surrounding the circle of the ring should be

divided into equal to or greater than 3 × 3 = 9 areas in obtaining a common vector that can precisely and quickly correct the displacement. It is also optional whether the size of the divided area is to be equal or is changed in accordance with the position.

[0083] Next, for the calculation of the displacement direction and displacement amount of the feature point, it is desirable to apply a scheme of associating feature points between two images or among plural images. According to this embodiment, the following scheme is applied which can associate feature points between two images at a fast speed. This scheme extracts vectors with a common direction among vectors with end points that are the feature point in the synthesis image and the feature point in the map image. As to the searching of the feature point in both images, all may be checked, but an examination may be carried out at random, and when there are common vectors within a predetermined threshold, such vectors may be extracted.

[0084] FIG. 13 C shows a result of a comparison between the feature points in a synthesis image (a) based on the synthesis image data and the feature points in a map image (b) based on the map image data. The arrows in the figure are simplified examples of displayed vectors. As illustrated in FIG. 13C, the displacement directions and displacement amounts of the respective areas differ from one another.

[0085] Next, the corrector 105d corrects (step 205), for each area, the positions of the feature points in the feature-point extraction data on the synthesis image data based on the obtained vectors. That is, the positions of the feature points in each area are moved based on the inverse vectors of the vectors obtained for each area.

[0086] The checkup processor 105e creates (step 206), for each area, the difference image based on the checkup of the corrected synthesis image data with the map image data. For example, as illustrated in FIG. 14A, when a subtraction of a similar value is performed on the pixel data of the

consistent part, the value becomes small. Accordingly, the color of this part becomes similar to a black color in the case of a gray scaling.

[0087] When a subtraction by a value with a large difference is performed on the pixel data of the inconsistent part, the absolute value becomes large. Hence, the color of this part becomes similar to a white color in the case of the gray scaling. In FIG. 14A, the map images are superimposed and displayed with a gray color.

[0088] Still further, the checkup processor 105e eliminates noises due to the displacement by what corresponds to about one to two pixels. FIG. 14B illustrates an image having undergone this noise elimination. In FIG. 14B, a condition in which the chip S is consistent upon checkup is illustrated.

[0089] For example, the determiner 105f binarizes the gray scale image, and determines (step 207) the inconsistent part based on the features, such as the shape and the size, through a blob analysis. The determination result contains data on, for example, the location of the inconsistent part, and the number thereof. However, the scheme of the inconsistency determining process is not limited to this scheme. All other schemes available currently or in future like normalization correlation are applicable.

[0090] Return to the flowchart of FIG. 7, the display-data creating unit 106 creates (step 113), based on the determination result through the checkup process, display data to display the determination result. The map checkup apparatus 100 transmits (step 114) the generated display data to the output unit 40, and the output unit 40 displays (step 115) the display data.

[0091] For example, FIGS. 15A and 15B illustrate an example display image based on the display data that represents the determination result. FIG. 15A is a case in which the checkup result is consistent. When the checkup result is consistent, there was no pickup error. FIG. 15B is a case in which the checkup result is inconsistent.

[0092] When the checkup result is inconsistent, this means the chip S to be picked up was not picked up, the chip not to be picked up was picked up, the chip S was come off from the dicing sheet D, and the like. In such a case, it can be determined as an inconsistent part. For example, in FIG. 15B, the inconsistent result (a part encircled by a circle in the figure) is distinguishably displayed by color coding (e.g., red color). This distinguishable display permits various forms, such as color coding, blinking, and brightness enhancement. On the display screen, the inconsistent part may be distinguishably displayed by a figure that surrounds the inconsistent part, or an arrow that points out the inconsistent part. Those forms may be combined and applied together. When the chip S not to be picked up disappears from the dicing sheet D, the defective product may be delivered, and the importance of the problem is high. Hence, the part where the chip S not to be picked up is not left may be further distinguishably displayed from the above-explained distinguishable display, or only the part where the chip S not to be picked up disappears may be distinguishably displayed. Still further, when the delivery of the chips S not to be picked up like the defective products becomes equal to or higher than a predetermined threshold, a control of outputting an alert to the output unit 40 or deactivating the apparatus, thereby preventing a further delivery is also possible.

[0093] [4. Effects]

The above-explained embodiments can accomplish the following effects.

(1) Based on only the feature of the chip S on the dicing sheet D having undergone the pickup operation, the position of the chip is specified, and the calculation is performed in consideration of the displacement direction and displacement amount of the chip due to the expansion of the dicing sheet D. Accordingly, even if the dicing sheet D has a partial distortion, the pickup result of the wafer W can

be checked precisely at a fast speed. In particular, a precise determination excluding the adverse effect of the distortion can be performed in comparison with cases in which the dicing sheet D is removed from the device to perform a checkup or the determination is based on the detection of the dicing grooves.

(2) In the map checkup apparatus 100, the displacement direction and displacement amount of the chip S due to the expansion, etc., of the dicing sheet D are calculated, and the synthesis image data or the map image data that is corrected based on the calculation result, and both data are checked with each other. Hence, it is unnecessary to remove the dicing sheet D from the ring R to carry out the examination, and the pickup result can be precisely examined within the apparatus and within a short time.

[0094] (3) The wafer W on the dicing sheet D is divided into plural areas, and the displacement direction and the displacement amount are calculated for each area. Hence, even if there is a difference in the displacement direction and the displacement amount in accordance with the position on the dicing sheet D, a further precise correction is possible.

[0095] In particular, the dicing sheet D is expanded by force in the direction from the internal side of the circle that encircles the wafer W to the external side thereof. Hence, the displacement direction and the displacement amount vary depending on the position on the dicing sheet D and the presence of the chip S or absence thereof. According to this embodiment, however, the wafer is divided into the plural areas, and the calculation is performed for each divided area, and thus the displacement direction and the displacement amount common to each area can be obtained. This enables a further precise correction.

[0096] (4) The feature points of each chip are extracted in order to calculate the displacement direction and the displacement amount. Since the contrast between each chip

S and the dicing sheet D is relatively clear, the feature points can be surely extracted.

[0097] In particular, by utilizing such feature points, the application of the above-explained scheme is enabled. The process of obtaining the vectors through the above-explained schemes is extremely fast, and thus the process can be further speeded up.

[0098] Still further, since the feature points are the corners of each chip, a large number of feature points can be extracted. Since the number of samples increases, the determination on the displacement direction and the displacement amount can be performed further precisely. In particular, the scheme suitable for detecting the corner at a fast speed as explained above is applied to extract the feature points, the process can be speeded up. Although there is a displacement, the directions of the chips S are substantially constant. Hence, the detection of the direction of the corner is easy.

[0099] (5) One of the images for checkup is created based on the map image data that is created on the basis of the device management map data owned by the map checkup apparatus 100. Hence, it is unnecessary to obtain additional particular information, and the examination can be carried out within the apparatus. In addition, the corrector 105d corrects the synthesis image data, and thus the positional precision of the chip S in the map image data can be maintained.

[0100] (6) The determination result is displayed on the output unit 40 in the form of the image that facilitates the operator to understand the distribution of the chips S in the ring. Hence, it is easy for the operator to recognize the consistency or inconsistency. In particular, since the inconsistency part is distinguishably displayed, a pickup error is further easily and precisely recognizable. Still further, a part where no defective product is left is distinguishably displayed, causing the operator to surely and

quickly recognize the important problem that is the delivery of the defective product.

[0101] [5. Other Embodiments]

The present disclosure is not limited to the above-explained embodiment. For example, according to the aforementioned embodiment, the synthesis image data is created based on the images obtained by horizontal reciprocating scanning after the completion of the pickup operation for the entire wafer W. However, the synthesis image can be created based on an image obtained by the imaging unit 61 in association with the pickup of each chip S. That is, when the image of the chip S right before the pickup is obtained, there is no chip S at the position of the chip S that has been picked up last time within the imaging range. Hence, as explained above, by sequentially updating the overlap part with the latest image data, the synthesis image data after the pickup operation can be created. When the imaging unit 61 obtains an image together with the pickup operation by the pickup mechanism 5, the process time can be reduced.

[0102] In addition, when the number of feature points is little within a particular area, in order to precisely determine the displacement direction and the displacement amount, the displacement direction and the displacement amount in that particular area may be determined based on information on the displacement directions and displacement amount of the surrounding areas. When, for example, the number of features points in the particular area is equal to or smaller than a predetermined threshold, the displacement calculator 105c may determine the vector of that area based on an average vector of the pieces of vector information of the plural surrounding areas or a vector that is a combination of vector components on the basis of the positional relationships among the surrounding areas. As an example case, it is presumed that the number of feature points is little at the upper left area. Force pulling upwardly is

large at the right area of that upper left area. In addition, force pulling leftward is large at the lower area of that upper left area. Hence, a scheme may be applied which combines the vector vertical element of the right area with the vector horizontal element of the lower area to determine the vector of that upper left area.

[0103] The structure of the pickup device 1 is not limited to the above-explained structure. For example, a structure may be employed in which the ring moving mechanism 2 and the pickup mechanism 5 perform, in the vertical direction, the pickup operation on the ring R disposed horizontally. In addition, a structure may be employed in which the pickup mechanism 5 and the imaging mechanism 6 are moved instead of moving the ring moving mechanism 2, and are positioned to the chip S on the ring moving mechanism 2.

[0104] It is appropriate if the map checkup apparatus 100 employs a structure that examine whether or not the pickup operation has been performed precisely based on the inspection result of the probe inspection in the pre-preparation process and also the inspection result when the visual inspection has been performed. Hence, it is not always necessary for the map checkup apparatus 100 to include the mechanism control unit 101 and the inspection unit 102, etc. That is, the map checkup apparatus 100 is a apparatus that can examine the pickup result based on data on the inspection result explained above.

[0105] As to the display data, it is optional whether the normal part is displayed or is not displayed. The normal part is a part where the chip S to be picked up is not left, and a part where the chip S not to be picked up is left, and according to the above-explained example, this part is the consistent part upon checkup. When the normal part is not displayed, it becomes further easy for the operator to recognize the part that has a problem. In addition, as to the determination by the determiner 105f, the consistent part may be determined. When, for example, the map image data is

utilized as data to create the image of the chip S to be picked up, the part consistent with the synthesis image data can be determined as the chip S that has not been delivered although this chip is a non-defective product.

[0106] When the determination results by the determiner 105f are accumulated in the memory unit 107, a tendency, such as a location where a pickup error is likely to occur, and whether the pickup error is likely to occur at the initial stage of the operation or is likely to occur after the operation has advanced, can be determined. An analyzing unit that analyzes such a tendency based on the determination result may be further provided, and the analysis result by this analyzing unit may be displayed on the output unit 40 in the form of textual information or an image. For example, a part where the pickup error frequently occurs (beyond a predetermined threshold) may be superimposed on the determination result display as explained above, and may be distinguishably displayed. A time at which the pickup error frequently occurs may be displayed on the display 40.

[0107] The specific contents and value of the information utilized in the present disclosure are optional, and are not limited to any particular contents and numerical value. In the large/small determination relative to a threshold, and the consistent/inconsistent determination, etc., it is optional to perform the determination based on criteria like equal to or greater than, and equal to or smaller than so as to include the threshold, or to perform the determination based on criteria like greater than, smaller than, exceeding, not exceeding, above, below, and less than so as not to include the threshold. For example, depending on the setting of the threshold, when the criterion like "equal to or greater than" is interpreted as "greater than", "exceeding" and "above", and the criterion like "equal to or smaller than" is interpreted as "smaller than", "not exceeding", "less than", and "below", the same determination result can be substantially obtained.

[0108] The above-explained embodiments are merely examples, and various omissions, replacements, and modifications can be made without departing from the scope of the present disclosure. Such embodiments and modified examples thereof are within the scope of the present invention as recited in the appended claims and the equivalent range thereto.

REFERENCE SIGNS LIST

[0109]

D	Dicing sheet
R	Ring
S	Chip
W	Wafer
1	pickup device
2	Ring moving mechanism
3	Expand mechanism
4	Separating mechanism
5	Pickup mechanism
6	Imaging mechanism
21	Ring holder
30	Input unit
31	Tensioner
40	Output unit
41	Pin
51	Sucking nozzle
61	Imaging unit
62	Prism
100	Map checkup apparatus
101	Mechanism control unit
102	Inspection unit
103	Synthesis-image creating unit
104	Map-image creating unit
105	Checkup unit
105a	Adjuster
105b	Feature extractor
105c	Displacement calculator
105d	Corrector

105e	Checkup processor
105f	Determiner
106	Display-data creating unit
107	Memory unit

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CLAIMS

1. A map checkup apparatus comprising:

a displacement calculator calculating a displacement direction of a chip and a displacement amount thereof due to an expansion of a dicing sheet based on synthesis image data to create an image of the dicing sheet having undergone a pickup of a chip that is a piece of a wafer, and having undergone the expansion of the dicing sheet on which the wafer having undergone dicing is attached, and map image data to create an image representing a position of a chip to be picked up or not to be picked up;

a corrector correcting at least either one of the synthesis image data and the map image data based on the displacement direction and the displacement amount both calculated by the displacement calculator; and

a determiner checking, between the synthesis image data and the map image data, the corrected data with the not-corrected data, and determining consistency or inconsistency therebetween.

2. The map checkup apparatus according to claim 1, wherein the displacement calculator divides the wafer on the dicing sheet into a plurality of areas, and calculates, for each area, the displacement direction and the displacement amount.

3. The map checkup apparatus according to claim 1 or 2, wherein the synthesis image data is image data based on the dicing sheet expanded by force in a direction from an internal side of a circle that encircles the wafer to an external side thereof.

4. The map checkup apparatus according to any one of claims 1 to 3, further comprising, in order to enable the displacement calculator to perform calculation, a feature

extractor extracting a feature point of each chip based on the synthesis image data and the map image data.

5. The map checkup apparatus according to any one of claims 1 to 4, further comprising a synthesis-image creator creating, based on image data obtained in association with a pickup of each chip, the synthesis image data.

6. The map checkup apparatus according to any one of claims 1 to 5, further comprising an inspector performing a visual inspection on each chip based on image data obtained in association with a pickup of each chip.

7. The map checkup apparatus according to any one of claims 1 to 6, further comprising, a map-image creator creating the map image data based on map data that contains information on at least either one of a non-defective chip in the wafer and a position of the non-defective chip, and, a defective chip in the wafer and a position of the defective chip.

8. The map checkup apparatus according to any one of claims 1 to 7, wherein the corrector corrects the synthesis image data.

9. The map checkup apparatus according to any one of claims 1 to 8, further comprising a display-data creator creating display data to display, on a display, a determination result by the determiner.

10. The map checkup apparatus according to claim 9, wherein the display data is image data that distinguishably displays a consistent part or inconsistent part between the synthesis image data and the map image data for the chip on the dicing sheet.

11. The map checkup apparatus according to any one of claims 1 to 10, wherein the display data is image data that distinguishably displays a part where the chip not to be picked up has been picked up on the dicing sheet.

12. The map checkup apparatus according to claim 4, wherein the feature point is a corner of each chip.

13. The map checkup apparatus according to claim 2, wherein the displacement direction of any one of the plurality of areas and the displacement amount thereof are calculated based on the displacement directions and the displacement amounts of the other areas.

14. The map checkup apparatus according to any one of claims 1 to 13, further comprising an analyzer determining a tendency of a pickup result by analyzing a determination result by the determiner.

15. A map checkup method executed by a computer or an electronic circuit, the method comprising:

a displacement calculating process of calculating a displacement direction of a chip and a displacement amount thereof due to an expansion of a dicing sheet based on synthesis image data to create an image of the dicing sheet having undergone a pickup of a chip that is a piece of a wafer, and having undergone the expansion of the dicing sheet on which the wafer having undergone dicing is attached, and map image data to create an image of a chip to be picked up or not to be picked up;

a correcting process of correcting at least either one of the synthesis image data and the map image data based on the displacement direction and the displacement amount both calculated through the displacement calculating process; and

a determining process of checking, between the synthesis image data and the map image data, the corrected data with

the not-corrected data, and determining consistency or inconsistency therebetween.

16. A map checkup program that causes a computer to execute:

a displacement calculating process of calculating a displacement direction of a chip and a displacement amount thereof due to an expansion of a dicing sheet based on synthesis image data to create an image of the dicing sheet having undergone a pickup of a chip that is a piece of a wafer, and having undergone the expansion of the dicing sheet on which the wafer having undergone dicing is attached, and map image data to create an image of a chip to be picked up or not to be picked up;

a correcting process of correcting at least either one of the synthesis image data and the map image data based on the displacement direction and the displacement amount both calculated through the displacement calculating process; and

a determining process of checking, between the synthesis image data and the map image data, the corrected data with the not-corrected data, and determining consistency or inconsistency therebetween.