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SPECIFICATION

TITLE OF THE INVENTION

BOARD RECOGNIZING APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

The present invention relates to a board recognizing apparatus and method for recognizing a position of a hole located at a specified location on a circuit board for use in the electronic component mounting process in which a lead of an electronic component are fitted into such a hole.

A conventional arrangement of board recognizing apparatus for recognition of hole positions in a circuit board is explained with reference to Figs. 3 to 5.

In Fig. 3, the conventional board recognizing apparatus comprises a belt 23 and rails 24 in combination for moving a circuit board 20, a light source 21 fixed above the circuit board 20 and having substantially same width as the circuit board 20, and a compact line sensor 22 fixed beneath the circuit board 20 and having a condenser lens. In an alternative, the light source 21 may be fixed beneath the circuit board 20, and the compact type line sensor 22 may be fixed above the circuit board 20.

Next, operation of the conventional arrangement is explained with reference to Figs. 3 to 5.

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In Figs. 3 to 5, when light is projected from the light source 21 toward the circuit board 20 as the circuit board 20 is moved by means of the belt 23 and rails 24 as shown in Fig. 3, light rays passing through holes 20a, 20b, 20c of the circuit board 20 are allowed to pass through the condenser lens for incidence on the compact type line sensor 22. Thus, positions of the holes 20a, 20b, 20c can be recognized by the compact type line sensor 22.

However, the foregoing conventional arrangement involves the following issues.

(1). As Fig. 4 shows, the angle of incidence θ of the light rays falling on the compact type line sensor 22 is such that in case of the hole 20a which is located at the middle of the board 20, the angle is zero, the angle becoming larger in proportion as the hole position goes nearer to either of the holes 20b, 20c located at edge portions of the board 20. Therefore, while the hole 20a located at the middle of the board 20 can be recognized to be of a circular shape in the case where the holes 20a, 20b, 20c are circular in shape, the holes 20b, 20c at edge portions of the board 20 will be recognized to be of a distorted circular shape. As such, positions of the centers of the holes 20b and 20c may not accurately be recognized.

(2). As Fig. 5 illustrates, where the board 20 has electronic components 25, 25 mounted thereon, the hole 20b goes out of sight because of the component 25 and cannot therefore be recognized as such.

(3). The compact type line sensor 22 is so limited in the number of pixels that the reading range of the sensor must be reduced if higher image resolution is to be obtained for enabling image recognition. Whilst, if the reading range is to be increased, the resolution aspect must be sacrificed.

(4). The speed of movement in a direction perpendicular to the compact type line sensor 22, that is, the speed of movement in the direction of transport of the board 20 must be uniform, or otherwise a read image is subject to expansion and contraction and cannot be relied upon for recognition of accurate position. Therefore, a high precision control is required to maintain the speed of transport of the board 20 at a uniform level.

(5). Since the board 20 moves relative to the recognizing section, it is required that at the recognizing section the belt 23 and rails 24 be twice as long as the board 20. This poses a limitation upon size reduction of the board recognizing apparatus.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a board recognizing apparatus and method which enable accurate recognition of a hole position within a board irrespective of a size of the board and of the presence or absence of a pre-mounted electronic component.

In accomplishing these and other aspects, according to a first aspect of the present invention, there is provided a board recognizing apparatus comprising:

- a light source section having a light source disposed transversely of a board having a hole for inserting a lead of a component so as to illuminate one surface of the board;

- a recognizing section including a lens disposed transversely of the board so as to face the board from an opposite side relative to the light source section and a line image sensor disposed transversely of the board for receiving light rays passing through the lens;

- a moving device for moving both the light source section and the recognizing section without changing relative positions of these sections but in such a way as to change their respective positions relative to the board;
- and

- an operating section for calculating image data for an entire board from image information obtained by the

recognizing section and position information obtained by the moving device.

According to a second aspect of the present invention, there is provided a board recognizing apparatus as set forth in the first aspect, wherein the lens and the line image sensor are each plural in number, and wherein the operating section composes pieces of image information from the plurality of line image sensors.

According to a third aspect of the present invention, there is provided a board recognizing apparatus as set forth in the first aspect, wherein the moving device is operative to move the light source section and the recognizing section integrally with each other toward the board at a stop position.

According to a fourth aspect of the present invention, there is provided a board recognizing apparatus as set forth in the second aspect, wherein the moving device is operative to move the light source section and the recognizing section integrally with each other toward the board at a stop position.

According to a fifth aspect of the present invention, there is provided a board recognizing apparatus as set forth in the first aspect, wherein the image data for the entire board from the image information obtained by the recognizing section and the position information

obtained by the moving device is calculated while the board is placed on a transport device for transporting the board.

According to a sixth aspect of the present invention, there is provided a board recognizing apparatus as set forth in the second aspect, wherein the image data for the entire board from the image information obtained by the recognizing section and the position information obtained by the moving device is calculated while the board is placed on a transport device for transporting the board.

According to a seventh aspect of the present invention, there is provided a board recognizing apparatus as set forth in the third aspect, wherein the image data for the entire board from the image information obtained by the recognizing section and the position information obtained by the moving device is calculated while the board is placed on a transport device for transporting the board.

According to an eighth aspect of the present invention, there is provided a board recognizing apparatus as set forth in the fourth aspect, wherein the image data for the entire board from the image information obtained by the recognizing section and the position information obtained by the moving device is calculated while the board is placed on a transport device for transporting the board.

According to a ninth aspect of the present invention, there is provided a board recognizing method comprising:

illuminating one surface of a board by a light source section having a light source disposed transversely of a board having a hole for inserting a lead of a component;

receiving light rays passing through a lens by a line image sensor disposed transversely of the board, a recognizing section including the lens disposed transversely of the board so as to face the board from an opposite side relative to the light source section and the line image sensor;

moving by a moving device both the light source section and the recognizing section without changing relative positions of these sections but in such a way as to change their respective positions relative to the board; and

calculating by an operating section image data for an entire board from image information obtained by the recognizing section and position information obtained by the moving device.

According to a tenth aspect of the present invention, there is provided a board recognizing method as set forth in the ninth aspect, wherein in calculating the

image data, when the lens and the line image sensor are each plural in number, the operating section composes pieces of image information from the plurality of line image sensors.

According to an eleventh aspect of the present invention, there is provided a board recognizing method as set forth in the ninth aspect, wherein in moving both the light source section and the recognizing section, the moving device is operative to move the light source section and the recognizing section integrally with each other toward the board at a stop position.

According to a twelfth aspect of the present invention, there is provided a board recognizing method as set forth in the tenth aspect, wherein in moving both the light source section and the recognizing section, the moving device is operative to move the light source section and the recognizing section integrally with each other toward the board at a stop position.

According to a thirteenth aspect of the present invention, there is provided a board recognizing method as set forth in the ninth, tenth, eleventh, or twelfth aspect, wherein in calculating the image data, the image data for the entire board from the image information obtained by the recognizing section and the position information obtained

by the moving device is calculated while the board is placed on a transport device for transporting the board.

According to the above arrangement of the first and ninth aspects, the light rays entering the line image sensor of the recognizing section are light rays emitted, for example, vertically downward from the light source section and passed through the hole of the board from above and in a vertically downward direction, which have thus passed through the lens, for example, vertically downward from above. In other words, the line image sensor views the portion to be recognized from right below or from right above. Therefore, the line image sensor can accurately recognize the configuration of a hole of the board, thus eliminating the issue of image distortion at board edge portions which would occur when a line sensor of the conventional compact type is used. Even where the board has an electronic component previously mounted on the underside thereof, there will be no occurrence of field-of-view shadow due to such an electronic component, and the entirety of the board can thus be accurately recognized.

In order to solve aforesaid issues, according to the second and tenth aspects, there are provided the plurality of lenses and the plurality of line image sensors, and the operating section composes pieces of image information from the plurality of line image sensors.

In this case, the use of the plural line image sensors makes it possible to recognize the entire area of the board which extends longer than the effective reading length of one line image sensor and, in addition, permits the use of inexpensive, popular size line image sensors which are generally widely used in facsimile and the like. This provides for cost reduction with respect to the apparatus.

Further, according to the third, fourth, eleventh, and twelfth aspects, with an intention to solve aforesaid issues, the moving device is operative to move the light source section and the recognizing section integrally with each other toward the board at a stop position.

In this case, the light source section and the recognizing section are moved without moving the board. This makes it possible to construct the apparatus generally to the length of the board and provides for size reduction of the apparatus. Furthermore, the moving velocity of the light source section and recognizing section relative to that of the board can be accurately controlled. This provides an advantage over the case in which the board is moved by transport device, with the light source section and recognizing section being held stationary, in that

image expansion and contraction possibilities can be eliminated.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view showing a board recognizing apparatus and method according to an embodiment of the present invention;

Fig. 2 is a diagrammatic view illustrating an image composing operation of the board recognizing apparatus;

Fig. 3 is a perspective view of a conventional board recognizing apparatus;

Fig. 4 is a diagram illustrating issues involved in the operation of the conventional board recognizing apparatus;

Fig. 5 is a diagram showing a further issue involved in the operation of the conventional board recognizing apparatus; and

Fig. 6 is a flow chart showing a board recognizing method according to the embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout the accompanying drawings.

A board recognizing apparatus and a board recognizing method according to one embodiment of the present invention is explained with reference to Figs. 1, 2, and 6.

In Fig. 1 which shows a perspective view of the one embodiment, numeral 4 designates a transport device comprising a belt 2 and rails 3 for transporting a board 1 placed thereon; 14 designates a stationary base set beneath the transport device 4; 13, 13 designate guide rails mounted on the upper surface of the stationary base 14 and in parallel with a transport direction in which the board 1 is transported by the transport device 4; 7 designates a moving carriage guided by the guide rails 13, 13 for back and forth movement on the stationary base 14 and in parallel with the transport direction of the transport device 4 in the directions of arrows A; 10 designates

moving carriage drive device provided on the stationary base 14 for moving the moving carriage 7 in parallel with the transport direction of the transport device 4 while issuing position signals from an encoder, the drive device 10 including a servo motor 8 into which the encoder is incorporated and a feed screw 9 driven in both directions by the motor 8; 5 designates a light source section supported by a light source section supporting arm 5a secured to the moving carriage 7, the light source section 5 including a light source disposed above the transport device 4 and set to the width of the transport device 4 in a direction perpendicular to the transport direction of the transport device 4; and 6 designates a recognizing section including two contact type line image sensors 12a, 12b, each of length C, extending in a direction perpendicular to the direction of movement of the moving carriage 7 and mounted on the moving carriage 7 so as to fit within the distance between the guide rails 13 and 13, with an overlap area D and a space B provided between the line image sensors 12a, 12b, and rod lenses 11a, 11b disposed above these sensors 12a, 12b. The rod lenses 11a, 11b each comprise a great number of SELFOCs ("SELFOC" is the trademark of Nihon Ita Garasu Kabushiki Kaisha for a gradient index lens), each of which is an optical system composed of arrangement of a great number of gradient index

lenses to form a single image as a whole and each of which functions as a thin microscope with a magnifying power of 1, as arranged in vertically parallel relation. The distance H between each rod lens 11a, 11b and the board 1 is about 15 mm.

In this embodiment, the light source section 5 and the recognizing section 6 are arranged in generally same position on the transport device 4. According to this arrangement, light rays entering the line image sensors 12a, 12b of the recognizing section 6 are light rays emitted vertically downward from the light source section 5 for passage through the holes of the board 1 from above and in a vertically downward direction, which have thus passed through the rod lenses 11a, 11b vertically downward from above. Thus, the line image sensors 12a, 12b can accurately recognize the holes of the board 1.

The line image sensors are arranged in two separate units 12a, 12b. This makes it possible to use readily available and inexpensive short-length line image sensors 12a, 12b, thereby enabling recognition of a wider-width board 1.

The apparatus also includes a controller 200 connected to the line image sensors 12a, 12b, the servo motor 13, and its encoder for detecting the positions of the line image sensors 12a, 12b. The controller 200 has an

operating section 201 for operating data such as image information obtained from the line image sensors 12a, 12b and a storage section 202 for storing information of the positions of the line image sensors 12a, 12b, the image information, and the data operated by the operating section 201, etc. The controller 200 also controls the driving of the servo motor 9 for moving the moving carriage 7.

Next, operation of the embodiment will be explained with reference to Figs. 1 and 2.

As Fig. 1 illustrates, with the two line image sensors 12a, 12b constituting the recognizing section 6, the position of the front side image sensor 12a is brought into alignment with the rear end E of the board 1 at a stop position (step S1). The servo motor 8 of the moving carriage drive device 10 is driven to actuate the feed screw 9 to move the moving carriage 7 forward (step S2). That is, the feed screw 9 is rotated in one direction in accordance with the rotation of the servo motor 8 and then the moving carriage 7 is moved in one direction while a nut incorporated into the moving carriage 7 is engaged with the feed screw 9. The quantity of movement made in this case is a length L of the board 1 plus the space B. In a first stroke for a distance corresponding to the space B, the front side line image sensor 12a only is to take in image information with respect to the board 1 (step S3). In a

next stroke, the two line image sensors 12a, 12b will, and in a final stroke for the distance corresponding to the space B, the line image sensor 12b only will take in image information with respect to the board 1.

The line image sensors 12a, 12b take in images within their respective share ranges while common data for the overlap area D within the effective take-in length C with a time difference corresponding to the space B. In this case, the line image sensors 12a, 12b can verify their respective positions through signals from the encoder of the servo motor 8.

Pieces of image information taken in by the line image sensors 12a, 12b are operated by the operating section 201, so that the image information for the overlap area D is processed for composition (step S4). Thus, image data for the entirety of the board 1 is obtained (step S5).

According to the foregoing arrangement, as earlier stated, light rays entering the line image sensors 12a, 12b of the recognizing section 6 are light rays emitted vertically downward from the light source section 5 and passed through the holes of the board 1 from above and in a vertically downward direction, which have thus passed through the rod lenses 11a, 11b vertically downward from above. In other words, the line image sensors 12a, 12b view the portion of the board 1 to be recognized from right

below through the "SELFOCs" of the rod lenses 11a, 11b. Therefore, the line image sensors 12a, 12b can accurately recognize the holes of the board 1, thus eliminating the issue of image distortion at board edge portions which would occur when line sensors of the conventional compact type are used. Even where the board 1 has electronic components previously mounted on the underside thereof, there will be no occurrence of field-of-view shadow due to such electronic components, and the entirety of the board 1 can thus be accurately recognized.

The use of plural line image sensors makes it possible to recognize the entire area of the board which extends longer than the effective reading length of one contact type line image sensor and, in addition, permits the use of inexpensive, popular size contact line image sensors which are generally widely used in facsimile and the like. This provides for cost reduction with respect to the apparatus.

By arranging that the light source section and the recognizing section are moved without moving the board, it is now possible to construct the apparatus generally to the length of the board and this in turn provides for size reduction of the apparatus. Furthermore, the moving velocity of the light source section and recognizing section relative to that of the board can be more

accurately controlled than the moving velocity of the transport device. This provides an advantage over the case in which the board is moved by transport device, with the light source section and recognizing section being held stationary, in that image expansion and contraction possibilities can be eliminated.

The board recognizing apparatus of the invention provides the following advantages.

(1). Board portions including median and edge portions can be accurately recognized, distortion-free.

(2). Previously mounted electronic components make no hindrance to board recognition.

(3). Recognition of larger boards is made possible through use of readily available, inexpensive short-length contact line image sensors which are generally widely used in facsimile and the like in plurality.

(4). Less space is required for board recognition, which provides for reduction of apparatus size.

(5). The issue of image expansion and contraction is eliminated.

Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are

apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.

WHAT IS CLAIMED IS:

1. A board recognizing apparatus comprising:

a light source section (5) having a light source disposed transversely of a board (1) having a hole for inserting a lead of a component so as to illuminate one surface of the board;

a recognizing section (6) including a lens (11a,11b) disposed transversely of the board so as to face the board from an opposite side relative to the light source section and a line image sensor (12a,12b) disposed transversely of the board for receiving light rays passing through the lens;

a moving device (7,10) for moving both the light source section and the recognizing section without changing relative positions of these sections but in such a way as to change their respective positions relative to the board; and

an operating section (201) for calculating image data for an entire board from image information obtained by the recognizing section and position information obtained by the moving device.

2. A board recognizing apparatus as set forth in claim 1, wherein the lens and the line image sensor are each plural in number, and wherein the operating section



composes pieces of image information from the plurality of line image sensors.

3. A board recognizing apparatus as set forth in claim 1, wherein the moving device is operative to move the light source section and the recognizing section integrally with each other toward the board at a stop position.

4. A board recognizing apparatus as set forth in claim 2, wherein the moving device is operative to move the light source section and the recognizing section integrally with each other toward the board at a stop position.

5. A board recognizing apparatus as set forth in claim 1, wherein the image data for the entire board from the image information obtained by the recognizing section and the position information obtained by the moving device is calculated while the board is placed on a transport device (4) for transporting the board.

6. A board recognizing apparatus as set forth in claim 2, wherein the image data for the entire board from the image information obtained by the recognizing section and the position information obtained by the moving device is calculated while the board is placed on a transport device (4) for transporting the board.

7. A board recognizing apparatus as set forth in claim 3, wherein the image data for the entire board from the image information obtained by the recognizing section



and the position information obtained by the moving device is calculated while the board is placed on a transport device (4) for transporting the board.

8. A board recognizing apparatus as set forth in claim 4, wherein the image data for the entire board from the image information obtained by the recognizing section and the position information obtained by the moving device is calculated while the board is placed on a transport device (4) for transporting the board.

9. A board recognizing method comprising:

illuminating one surface of a board (1) by a light source section (5) having a light source disposed transversely of a board (1) having a hole for inserting a lead of a component;

receiving light rays passing through a lens (11a,11b) by a line image sensor (12a,12b) disposed transversely of the board, a recognizing section (6) including the lens disposed transversely of the board so as to face the board from an opposite side relative to the light source section and the line image sensor;

moving by a moving device (7,10) both the light source section and the recognizing section without changing relative positions of these sections but in such a way as to change their respective positions relative to the board; and



calculating by an operating section (201) image data for an entire board from image information obtained by the recognizing section and position information obtained by the moving device.

10. A board recognizing method as set forth in claim 9, wherein in calculating the image data, when the lens and the line image sensor are each plural in number, the operating section composes pieces of image information from the plurality of line image sensors.

11. A board recognizing method as set forth in claim 9, wherein in moving both the light source section and the recognizing section, the moving device is operative to move the light source section and the recognizing section integrally with each other toward the board at a stop position.

12. A board recognizing method as set forth in claim 10, wherein in moving both the light source section and the recognizing section, the moving device is operative to move the light source section and the recognizing section integrally with each other toward the board at a stop position.

13. A board recognizing method as set forth in claim 9, wherein in calculating the image data, the image data for the entire board from the image information obtained by the recognizing section and the position information



obtained by the moving device is calculated while the board is placed on a transport device (4) for transporting the board.

14. A board recognizing method as set forth in claim 10, wherein in calculating the image data, the image data for the entire board from the image information obtained by the recognizing section and the position information obtained by the moving device is calculated while the board is placed on a transport device (4) for transporting the board.

15. A board recognizing method as set forth in claim 11, wherein in calculating the image data, the image data for the entire board from the image information obtained by the recognizing section and the position information obtained by the moving device is calculated while the board is placed on a transport device (4) for transporting the board.

16. A board recognizing method as set forth in claim 12, wherein in calculating the image data, the image data for the entire board from the image information obtained by the recognizing section and the position information obtained by the moving device is calculated while the board is placed on a transport device (4) for transporting the board.

