

Description

Method for detecting the position of components placed on a substrate in a pick-and-place robot

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The invention relates to a method for detecting the position of components placed on a substrate in a pick-and-place robot.

10 In the automatic population of substrates (for example printed circuit boards or ceramic substrates) with SMD components (SMD = surface mounted device), the individual components are removed from a feed device by means of a pick-and-place head and then positioned in a predefined position on the substrate.

15 DE 41 21 404 discloses a method in which an inspection is carried out to see whether all component has also been positioned in the predefined position is carried out outside the pick-and-place robot after the pick-and-place process. In addition, it is proposed
20 there that a positional correction or repopulation then be carried out. Since the pick-and-place robot in this case is not designed to detect the position, the populated substrate has to be supplied to a separate device, which is too time-consuming in the fabrication
25 process.

To some extent, the position of the components after being placed in a pick-and-place robot is checked visually outside the pick-and-place robot in separate machines. DE 36 18 590 discloses the practice of
30 placing components even over components which have already been placed, and the components located underneath are then no longer accessible to visual inspection, so that, for example, complicated X-ray inspection devices have to be used.

35 US 5,003,692 discloses a method in which, by means of a specially constructed suction pipette, a camera arranged behind it

with an image evaluation unit records an image of the substrate before the component is put in place, and also an image of the substrate with the component put in place after it has been put in place. For each
5 component, the position is therefore checked after being put in place. The construction of the suction pipette needed for this is very complicated, however, and the time-intensive recording of the position of each component put in place is generally not necessary.

10 A faulty position of a component after the conclusion of the pick-and-place process is often discovered by means of a negative electrical functional check. In this case, eliminating the fault can often no longer be considered, and the substrate can no longer
15 be used.

The object is, therefore, to specify a simple method for detecting the position of components on a substrate by which means the components are checked for their actual position in good time.

20 The object is achieved by a method of the type named at the beginning having the features of claim 1.

By comparing the actual position with a predefined position directly in the pick-and-place robot, after the pick-and-place process, no separate
25 machines for visual inspection are needed any more. The pick-and-place process is therefore not interrupted, nor, for example, are any separate programs for the separate machine and the pick-and-place robot necessary. As a result of the predefined choice of the
30 components to be checked, a time advantage can be achieved as compared with checking each component.

An additional advantage is to be seen in the fact that a faulty position is already detected in good time, and therefore the faulty substrate is sorted out,
35 without still further

cost-intensive pick-and-place processes or else other processes (soldering) being performed.

If necessary, in the event of detecting the faulty position in good time, it is also possible for a
5 positional correction - for example a manual correction - to be carried out or for the faulty pick-and-place operation to be repeated.

In an advantage refinement according to claim 2, the sensor used is a camera with an image
10 evaluation unit connected downstream. Such sensors, and the methods of image analysis, are technically sophisticated and known and permit the position to be detected in a straightforward way.

Use is preferably made of the method according
15 to claim 3 in the event that a number of components are placed one above another. In this case, components is also understood to mean, for example, cooling plates which are placed over electronic components in the pick-and-place robot. Even relatively large components
20 are to some extent placed over already placed smaller components in order to save space. By means of the method according to the invention, the position of the components located underneath can be determined before the components located above are placed, which
25 dispenses with complicated X-ray examinations.

The sensor according to claim 4 can advantageously be moved together with the pick-and-place head, as a result of which each component placed on the substrate comes into the field
30 of view of the sensor. As a result, an additional complicated design of a sensor is avoided.

In a preferred refinement of the method, according to claim 5, the sensor is also used to determine the position of the substrate in the
35 pick-and-place robot, which means that only one sensor is cost-effectively needed for these two processes.

In order to save time, it is advantageous to determine the position of the substrate in the pick-and-place robot only once before the pick-and-place operation, according to claim 6.

5 The method is preferably used to optimize the positional accuracy of the pick-and-place robot according to claim 7. Using known optimization algorithms, the positional accuracy in pick-and-place robots can thus be improved from component to
10 component.

The invention will be explained in more detail using the exemplary embodiment illustrated in the drawing, in which:

Figure 1 shows a schematic side view of a
15 pick-and-place robot,

Figure 2 shows a schematic section through a substrate fitted with a component, and

Figure 3 shows a schematic section through a substrate with two components fitted one above another.

20 With the aid of a pick-and-place robot 1 illustrated in figure 1, components 15 are removed from feed units (not illustrated) with the aid of a holding device 5 (for example suction pipettes) and positioned on a substrate 2 in a predefined position. The
25 substrate 2 is in this case transported into the pick-and-place robot by means of a transport device 3. The holding devices 5 are fixed by a fixing device 6 to a pick-and-place head 4 of the pick-and-place robot 1 which - monitored by a control device 7 - moves in the
30 x-y direction, parallel to the substrate 2. As a result, all the positions on the substrate 2 can be reached. A sensor 10, for example a camera comprising an optical detector 11, an optical imaging device 12 and an image evaluation unit (not illustrated), which
35 can be arranged in the control device, for example, registers in its field of view 13 at least some extent of the fitted

component 15. If the sensor 10 is fixed to the pick-and-place head 4, its field of view 13 can reach every point of the substrate 2 in the pick-and-place robot. Such sensors 10 are, for example, also used to
5 determine the position of the substrates 2 in the pick-and-place robot 1. During the pick-and-place process, the determined position of the substrates 2 is then used for the precise positioning of the components 15 on the substrate 2.

10 Using the sensor 10, the position of placed components 15 is determined. In order to check whether the component is located in the predefined position at all and is not, for example, not present at all, a simple height sensor is also suitable as sensor 10, for
15 example a commercially available triangulation sensor.

Which components 15 are to be checked in detail for their position was stored in the control device 7, together with the predefined position, before the sequence of the pick-and-place process. The image
20 evaluation unit compares the predefined position with the actual position, and the result is further used as follows. In the event of a positive result, the pick-and-place process is continued, in the case of a negative comparison a fault message is output. The
25 fault message can then, for example, lead to the erroneously fitted substrate being detected as such early and removed from the further process. In this way, costly further process steps are dispensed with.

The method is applied particularly
30 advantageously if, as illustrated schematically in section in figures 2 and 3, a further component 16 (for example a larger component or a cooling plate) is placed over a component 15 that has already been placed. Detecting the position in the pick-and-place
35 robot 1 makes it possible to carry out a detection of the position of the lower component 15 before placing the further component 16, which would otherwise be

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possible only with complicated methods, for example
X-ray methods.

Detecting the position of the placed components 15 in the pick-and-place robot 1 can also be used in order to increase the positional accuracy of the pick-and-place robot 1 during the pick-and-place process. If, for example, the control unit 7 determines that there are regular deviations between the predefined and actual position of the components 15, the pick-and-place process is adapted, using methods known per se, until predefined and actual positions coincide better.

By means of the method, early detection of the position of placed components 15 is therefore made possible.

Patent claims

1. A method for detecting the position of components (15) placed on a substrate (2) in a pick-and-place robot (1), in which
5 a predefined position of the components (15) is stored in a control device (7) of the pick-and-place robot (1) before they are placed,
a selection of the components (15), which is
10 subsequently inspected, is stored in the control device (7),
with the aid of a sensor (10) in the pick-and-place robot (1), the actual position of the selection of components (15) on the substrate (2) is determined
15 after they have been placed,
the actual position is compared with the predefined position and
if there is agreement within a predefined framework between the predefined and actual positions, the
20 pick-and-place process is continued, and otherwise a fault message is output.
2. The method for detecting the position of components (15) placed on a substrate (2) in a pick-and-place robot (1) as claimed in claim 1,
25 characterized in that the sensor (10) used is a camera with an image evaluation unit connected downstream.
3. The method for detecting the position of components (15) placed on a substrate (2) in a pick-and-place robot (1) as claimed in either of
30 claims 1 and 2, characterized in that the position is detected, via the component (15) already placed, before a further component (16) is placed.

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4. The method for detecting the position of components (15) placed on a substrate (2) in a pick-and-place robot (1) as claimed in one of claims 1, 2 or 3, characterized in that the sensor (10) is fixed to a pick-and-place head (4) of the pick-and-place robot (1) and is therefore moved together with the pick-and-place head (4).

5. The method for detecting the position of components (15) placed on a substrate (2) in a pick-and-place robot (1) as claimed in one of claims 1 to 4, characterized in that the sensor (10) is also used to determine the position of the substrate (2) in the pick-and-place robot (1).

6. The method for detecting the position of components (15) placed on a substrate (2) in a pick-and-place robot (1) as claimed in claims 1 to 5, characterized in that the position of the substrate (2) in the pick-and-place robot is determined only once, before the pick-and-place operation.

7. Use of the method as claimed in one of claims 1 to 6 in a pick-and-place robot to improve the positional accuracy of the pick-and-place process for subsequent pick-and-place processes by using the results of the position detection.

