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Description

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

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

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.

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 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 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 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.

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 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.

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 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.

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 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 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, 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 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 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 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 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 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 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 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.

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 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 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.

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 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 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 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 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.

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 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 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 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 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 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

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.

What is claimed is:

1. A method for position recognition of components placed on a substrate comprising the steps of:

in a plurality of components, identifying certain components as pre-identified components requiring more precise positioning than other components in said plurality;

in an equipping process after said certain components have been pre-identified, picking up a component, as a picked-up component from among said plurality of components with an equipping head of an automatic equipping unit;

in a control unit of said automatic equipping unit, storing a predetermined position at which said picked-up component is to be placed on a substrate;

placing said picked-up component at an actual position on said substrate using said equipping head;

using a position sensor mounted on said automatic equipping unit after placement of said picked-up component on said substrate, only if said picked-up component is one of said pre-identified components, identifying said actual position of said pre-identified component on said substrate after placing said pre-identified component on said substrate;

comparing said actual position to said predetermined position; and

if said predetermined position and said actual position coincide within a predetermined range, continuing said equipping process, and if said predetermined position and said actual position are outside of said predetermined range, generating an error message.

2. A method as claimed in claim 1 wherein the step of mounting a position sensor on said automatic equipping

unit comprises mounting a camera connected to an image evaluation unit on said automatic equipping unit as said position sensor.

3. A method as claimed in claim 1 wherein said component comprises a first component, and wherein said equipping process includes placing a second component on said substrate over said first component, and wherein the step of identifying the position of said first component on said substrate is undertaken before placing said second component over said first component.

4. A method as claimed in claim 1 wherein the step of mounting said position sensor on said automatic equipping unit comprises mounting said position sensor to said equipping head so that said position sensor and said equipping head move together.

5. A method as claimed in claim 1 comprising the additional step of employing said position sensor for identifying a position of said substrate relative to said equipping head.

6. A method as claimed in claim 1 comprising the additional steps of, upon each comparison of said actual position with said predetermined position, conducting a procedure to improve a subsequent placement of another component on a substrate.