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Description



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Method for setting the illumination in a device
for identifying the position and/or controlling the
5 quality of components and/or substrates

The invention relates to a method for setting
the illumination in a device for identifying the
position and/or controlling the quality of components
10 and/or substrates according to the preamble of Patent
Claim 1.

In the context of the automatic mounting of
components, in particular SMD (surface mounted device)
components on printed circuit boards or ceramic
15 substrates, prior to the component-mounting process the
position of the components relative to the emplacement
position on the printed circuit board is determined by
means of devices for position identification. In the
text below, the term components encompasses all objects
20 that can be mounted, for example including shielding
plates. Vision systems are generally used as position
identification devices, said vision systems comprising
a camera, for example a CCD camera, and an illumination
device. The components are inspected visually in
25 devices of analogue construction which serve for
quality control, in order to identify defective
components and remove them from the component-mounting
process.

Centring markings applied on the substrates
30 serve for identifying the position of the substrates.
Reject markings applied on the substrates are used for
marking defective substrates, in order that the said
defective substrates are identified in the device for
quality control and are subsequently removed from the
35 component-mounting process. A wide variety of
substrates (epoxy/glass fibre composites, plastic
films, ceramics, hard paper) are used. A variety of
materials, such as lustrous or matt metals/metal oxides

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or plastic or lacquer coverings, are used for the markings, too. The optical surface properties

of these different materials for substrates and markings vary extremely, and thus so does the contrast between the marking and the substrate which is caused by illumination. Therefore, the illumination should be
5 chosen such that useful structures (in general the connections of the components or the markings) are represented with very high contrast with respect to defective structures (for example the body of the components or substrate background).

10 For this purpose, methods are known in which the components are illuminated from different angles with different intensities with the aid of illumination devices which are subdivided into a plurality of illumination units each with intensity control that can
15 be regulated separately. In this case, the illumination devices have a virtually constant spectral distribution.

WO 96/21343 discloses, by way of example, a method in which, with the aid of segmented ring
20 illumination, the components are not illuminated uniformly from all angles, rather no light falls onto the structure from specific angles. This suppresses imaging of defective structures that emerge particularly conspicuously at these specific angles.

25 In this case, markings and substrates and/or components are each produced from materials having mutually different optical properties, such as absorption, metallic or diffuse reflection, in order to be distinguished from one another in an image
30 evaluation unit due to their respectively different backscattering behaviour in the event of illumination with an illumination device with a virtually constant spectral distribution. The optical properties vary with the wavelength of the illuminating light, with the
35 result that, in a disadvantageous manner, specific material combinations for markings, substrates and/or components cannot be distinguished from one another in

the event of illumination with a virtually constant
spectral

distribution. Exchanging the illumination devices depending on the materials used is very laborious and it cannot be carried out if a high component-mounting performance is to be striven for, because of the time
5 that is lost.

JP 5-332939 discloses a method for controlling the quality of components with a number of illumination units which each have dedicated intensity control devices. In this case, the light emitted by the
10 illumination units is varied by variation of the intensity until an optimum illumination (maximum contrast) is achieved, in the case of which the component is reliably identified.

JP 8-219716 discloses a method for illuminating
15 objects with different colours, in which the colour of the light emitted by an illumination unit is varied by way of an illumination control.

The use of different colours for optimizing the contrast is made more difficult by the fact that, in
20 the known method the operator himself has to set the optimum contrast for each component that is examined.

The object of the invention, therefore, is to specify a method for setting the illumination which ensures reliable identification when different
25 materials are used for substrates, markings and/or components and, at the same time, effects rapid identification for components of the same type.

The object is achieved according to the invention with a method of the type mentioned in the
30 introduction with the characterizing features of Patent Claim 1.

By comparison with the known methods, the method according to the invention has the advantage that the spectral distribution of the illumination is
35 varied by variation of the parameters of the

intensity control device. Since the reflection and/or backscattering behaviour of the materials for components, markings and substrates are dependent on wavelength, colour-optimized illumination is attained which enables improved contrast between defective and useful structures for components, substrates and/or markings which are produced from different materials. In this case, for a group of identical components and/or markings, first of all the optimized illumination setting is determined for a first component and/or a first marking. The resultant parameters for the intensity setting are stored and can be used for illuminating further components and/or markings. This ensures that identical components and/or markings can be identified equally well.

In a refinement of the method according to Claim 2, which refinement is particularly simple to realize, the illumination units each emit light in a narrowband spectral range, where different illumination units emit light in different spectral ranges. The intensities of the individual illumination units are varied by the intensity control devices respectively assigned to the illumination units, illuminations with a different spectral intensity colour distribution thereby being set.

In a further refinement according to Claim 3, illumination units whose emission wavelength is variable are used. In this case, the emission wavelength is likewise varied by the intensity control device. As a result, fewer illumination units are used and a more compact design is attained.

In the advantageous refinement of the method according to Patent Claim 4, the optimized illumination is determined

automatically, which leads to better reproducibility in the setting of the illumination.

In the method in accordance with Claim 5, in an advantageous manner, the intensity of a group of illumination units which each emit light in a common spectral range is varied jointly. As a result, the number of intensity control devices that have to be driven individually is reduced and thus so is the time taken for determining an optimized illumination.

The invention is explained in more detail with reference to an exemplary embodiment and the figures of the drawing, in which

Figure 1 shows a diagrammatic illustration of an automatic component-mounting machine for mounting components on substrates,

Figure 2 diagrammatically shows an illumination apparatus for illuminating substrates with markings, and

Figure 3 diagrammatically shows an illumination apparatus for illuminating components.

Figure 1 illustrates how a component-mounting head 2 situated on a portal 1 in an automatic component-mounting machine can be moved in the X- and Y-directions with the aid of motors (not illustrated). Suction pipettes 3, 12 of them in this example, are fixed on the component-mounting head and are used to pick up components (not illustrated) from feed devices 4 and deposit them on substrates 5 at a predetermined position. The term substrate 5 encompasses both printed circuit boards and ceramic substrates. In this case, the substrates 5 are conveyed in the X-direction by a substrate moving apparatus 6. In order to correct the position of the components with respect to the substrate 5, markings 7 are applied on the substrate 5, which markings are imaged by an illumination device 8 and stored in an image evaluation unit 9. In this example, a monitor for visual observation is arranged as the image evaluation unit 9. In addition to centring

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markings 7 for identifying the position of the
substrate 5, reject markings 7 are

also detected in this way, the said reject markings having been applied on substrates 5 which are unsuitable for the rest of the component-mounting process. These unsuitable substrates 5 are identified
5 in this way and subsequently removed from the component-mounting process.

In the method according to the invention, an apparatus as illustrated in Figure 2 is used, by way of example, as the illumination device 8. In this case, a
10 camera 11, for example a CCD camera, records the image of the substrate 5 with the markings 7 and stores the imaging in an image evaluation unit 9 connected downstream. The substrate 5 with the markings 7 is illuminated by illumination units 12, 14, 16, first
15 illumination units 12 emitting light in a narrow spectral range around a first wavelength, whose intensity is varied by a common intensity control device 13. In addition, second illumination units 14 are provided, which emit light in a second narrowband
20 spectral range around a second wavelength and whose intensity is varied by a common intensity control device 15, and third illumination units 16 are provided, which emit in a third narrowband spectral range around a third wavelength and whose intensity is
25 varied by a third intensity control device 17. In this case, the illumination units 12, 14, 16 are fixedly connected to the camera 11 by a fixing apparatus 18, in order that they can be moved simultaneously with the camera 11 over the substrate 5. The illumination units
30 12, 14, 16 are in this case designed as a ring-shaped light source, for example. For optimized illumination, the intensity of the individual illumination units 12, 14, 16 is varied in which the parameters at the assigned intensity control devices 13, 15, 17 are
35 varied until optimized illumination with optimized contrast is recorded by the camera 11 and stored in the image evaluation unit 9. When variable-wavelength

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illumination devices 12, 14, 16, such as, for example,
variable-wavelength light-emitting diodes,

are used, the emitted spectral range is varied by the intensity control devices 13, 15, 17.

If, during the component-mounting process, a plurality of identical substrates 5 with identical markings 7 are illuminated and their images are recorded, then, in a training phase, first of all the optimized illumination setting is determined only at one marking 7, the corresponding parameters are stored and the further identical markings 7 are exposed to the optimum illumination assigned to these parameters. This procedure can be automated for example as follows: at the beginning of the component-mounting process, the defective structures and the useful structures of the markings 7 and of the substrates 5 are stored as geometrical structures and, during the training phase, the intensities of the various illumination units 12, 14, 16 are varied, the corresponding imagings are stored, the contrasts obtained therefrom are determined and the optimized contrast and thus the optimized intensity settings are determined therefrom. Figure 2 also already illustrates that the various illumination units 12, 14, 16 illuminate the substrate 5 and thus the markings 7 from different directions. Light-emitting diodes are particularly suitable as illumination units 12, 14, 16 since they are inexpensive and their intensity can be regulated in a simple manner. It is possible to obtain light-emitting diodes emitting in different spectral colours. Moreover, light-emitting diodes can easily be arranged in a matrix, a large-area illumination device 8 thereby being obtained.

Figure 3 illustrates that the method according to the invention is also suitable for the illumination of components 19 on the suction pipette 3 of a component-mounting head 1, in order to determine the position of the component. In this case, in general, the connections of the components 19 form the useful structures and the body of the component 19 the

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defective structures. By analogy with the above-described method with markings 7 and substrates 5, in a training

phase, first of all the optimum illumination is determined for a first component 19 and subsequently used for further identical components 19.

The method according to the invention therefore
5 has the advantage of ensuring optimized illumination in each case for components 19, substrates 5 and/or markings 7 composed of very different materials.

Claims

1. A method for optimally illuminating a group of objects an object having substantially identical object features, comprising the steps of:
- 5 placing a first object in a group of objects in a field of view of a camera and obtaining an image of said object, said first object having an object feature and said object feature being present in said image;
- while said first object is in the field of view of said camera, illuminating said first object with illuminating light formed by emitted light from a plurality of illumination
- 10 sources, the emitted light from each illumination source having a spectral distribution;
- providing a control device for each of said illumination sources and controlling said illumination sources by varying parameters of said control devices to vary the spectral distribution of the emitted light from each of said illumination sources until
- 15 an optimized illumination of said first object by said illuminating light is achieved at which said object feature is reliably recognizable in said image;
- storing said parameters which produce an optimized illumination of said first object as stored parameters; and
- setting said control devices with said stored parameters for illuminating all other
- 20 objects in said group.
2. A method as claimed in claim 1 wherein each of said illumination sources has a wavelength allocated thereto and wherein the step of illuminating said object comprises, for each illumination source in said plurality of illumination sources,
- 25 emitting said emitted light in a narrowband spectral range around a wavelength allocated to the illumination source, with the wavelengths respectively allocated to at least two of said illumination sources being different from each other, and wherein the step of controlling said illumination sources comprises separately and individually varying the parameters of the control devices respectively provided for
- 30 said illumination sources.

3. A method as claimed in claim 2 wherein the step of varying parameters comprises varying parameters of said control devices for varying the respective wavelengths allocated to the illumination sources.

5 4. A method as claimed in claim 1 wherein said object feature comprises a geometrical structure of an object, said geometrical structure including unwanted structures and useful structures, and said method comprising the step of determining said optimized illumination of said first object by the steps of:
illuminating said first object of said group and varying parameters of said control
10 devices until an optimum contrast between the unwanted structures and the useful structures of said first object is obtained;
storing the parameters of said control devices which produced said optimum contrast for said first object as said stored parameters; and
employing the stored parameters which produced said optimum contrast for
15 setting said control devices for illumination of all other objects in said group.

5. A method as claimed in claim 1 wherein each of said illumination sources produces the emitted light therefrom in a narrowband range around a wavelength allocated to the illumination source, with at least two of said illumination sources
20 having the same wavelength allocated thereto, and wherein the step of varying parameters of said control devices comprises commonly varying parameters of the control devices provided for the at least two illumination sources to which the same wavelength is allocated.

25 6. An apparatus for optimally illuminating a group of objects having substantially identical object features, comprising:
a camera having a field of view;
means for placing a first object of a group of objects in said field of view of said camera, said camera obtaining an image of said first object, said first object having
30 an object feature and said object feature being present in said image;
means for illuminating said first object while said first object is in the field of view of said camera, with illuminating light formed by emitted light from a plurality of

illumination sources, the emitted light from each illumination source having a spectral distribution;

a plurality of control devices respectively connected to said illumination sources and controlling said illumination sources by varying parameters of said control devices to vary the spectral distribution of the emitted light from each of said illumination sources until an optimized illumination of said first object by said illuminating light is achieved at which said object feature is reliably recognizable in said image;

means for storing said parameters which produce an optimized illumination of said first object as stored parameters; and

means for setting said control devices with said stored parameters for illuminating all other objects in said group.

7. An apparatus as claimed in claim 6 wherein each of said illumination sources has a wavelength allocated thereto, each said illumination source in said plurality of illumination sources emitting said emitted light in a narrowband spectral range around the wavelength allocated to the illumination source, with the wavelengths respectively allocated to at least two of said illumination sources being different from each other, and wherein said control devices separately and individually vary the parameters of the respective control devices.

8. An apparatus as claimed in claim 6 wherein said control devices vary the respective wavelengths allocated to the illumination sources.

9. An apparatus as claimed in claim 6 wherein said object feature comprises a geometrical structure of an object, said geometrical structure including unwanted structures and useful structures, and wherein said means for illuminating comprises means for illuminating said first object of said group while varying parameters of said control devices until an optimum contrast between the unwanted structures and the useful structures of said first object is obtained, said apparatus further comprising:

means for storing the parameters of said control devices which produced said optimum contrast for said first object as said stored parameters; and

means for employing the stored parameters which produced said optimum contrast for setting said control devices for illumination of all other objects in said group.

10. An apparatus as claimed in claim 6 wherein each of said illumination sources produces the emitted light therefrom in a narrowband range around a wavelength allocated to the illumination source, with at least two of said illumination sources having the same wavelength allocated thereto, and wherein said apparatus further comprises means for commonly varying parameters of the control devices provided for the at least two illumination sources to which the same wavelength is allocated.