[0054] At step S14, a composite distance index C(i ,j) for i-th representative color vector and j-th individual color vector is calculated according to the following equations (5a) or (5b).

$$C(i, j)=V(i, j)+D(i, j) \quad (5a)$$

$$C(i, j)=V(i, j)*D(i, j) \quad (5b)$$

[0055] In the equation (5a), the sum of the angle index V(i ,j) and the distance index D(i ,j) is employed as the composite distance index C(i ,j). In the equation (5b), the product of the angle index V(i ,j) and the distance index D(i ,j) is employed as the composite distance index C(i ,j). Accordingly, the composite distance index C(i ,j) given by the equation (5a) or (5b) tends to get smaller as an angle between an individual color vector of a j-th pixel and an i-th representative color vector gets smaller and as a distance between the corresponding individual color and the representative color in the color space gets smaller.

[0056] After the composite distance indices C(i ,j) regarding the plural representative colors are calculated for each pixel color, each individual pixel color is classified into one of the representative color clusters that provides the smallest composite distance index C(i ,j), at step **S15**. The term "cluster" refers to a group of colors associated with one representative color. Since N composite distance indices C(i ,j) are obtained for N representative colors for every pixel, the individual color of each pixel is classified into a representative color cluster that provides the smallest one among the N composite distance indices.

[0057] **FIG. 7** shows the distribution of individual colors classified into four representative color clusters. As explained with **FIG. 4**, four representative colors corresponding to four color regions, green region GR, gold region GL, brown region BR, and white region WH, are set at step S2 (**FIG. 2**). Therefore, in **FIG. 7**, individual pixel colors are grouped into the representative color clusters CL_{GR}, CL_{GL}, CL_{BR}, and CL_{WH} corresponding to these four colors. In this figure, distances are small between dark individual colors in the gold cluster CLGL (the colors proximate to the origin of the three-dimensional space) and dark individual colors in the brown cluster CL_{BR}. However, since the above-described composite distance indices C(i ,j) are used in the classification or grouping of individual colors in the present embodiment, each of the individual pixel colors is classified into one of the representative color clusters such that the individual color and the representative color have a small distance between them and also have a small angle between their vectors. Accordingly, it is unlikely that the inappropriate clustering shown in **FIG. 10**B and described in the background of the invention is performed, but more appropriate clustering is possible.

[0058] In this way, after each individual pixel color has been classified into one of the representative color clusters, the color region divider **140** then divides the image region according to the classification of the pixels at step **S5** in **FIG. 3**. For example, the image region is divided by allocating specific numbers (representative color numbers) to the pixels of each cluster. Specifically, pixel values 0, 1, 2, and 3 are allocated to clusters CLGR, CL_{GL}, CL_{BR}, CL_{WH} in **FIG. 7**, respectively, for example. In the following description, a region allocated with a same representative color number at step **S5** is referred to as "a representative color region."

[0059] At step S**6**, the color region divider **140** unites the representative color regions if required. In the present embodiment, the gold region GL and the brown region BR are specified to be united together at step S2, as described with **FIG. 4**. These regions GL, BR are united together to form a second divided region DR**2** at step S**5**.

[0060] **FIG. 8** shows the united divided regions displayed on the display of the computer **40**. The first to third divided regions DR**1**-DR**3** are displayed with different colors or patterns according to their representative color numbers, respectively. It is previously set by the user how each divided region will be filled on the display according to the representative color number. Alternatively, the color region divider **140** may automatically determine the relationship between each representative color number and the displayed color. As can be appreciated from this example, in the first embodiment, a color image is first divided into a plurality of representative color regions and some of the representative color regions are then united together if required. By employing such process, regions with different colors can be advantageously united into one divided region according to a user's request.

[0061] After the image region of the color image is divided into plural divided regions, the post-processor **150** performs post-processing at step **S7** in **FIG. 3**. The post-processing includes a process of noise removal including a choking process (contraction process) of each region and its spreading process (expansion process). The noise removal is attained by executing the choking process with a predetermined pixel width and then the spreading process with the same pixel width for the pixels in a target divided region. Other divided regions can also be applied with the choking and spreading processes. Such post-processing is capable of removing small regions or noises called pin holes.

[0062] As described above, in the first embodiment, the composite distance index C(i, j) ix calculated based on the distance index that substantially represents a distance between each individual pixel color and a representative color and on the angle index that substantially represents an angle between each individual color vector and a representative color vector, and then each individual pixel color is classified into one of representative color regions that provides the smallest C(i, j). Accordingly, it is possible to classify pixels with a same original color into a same representative color region even if they have significantly different values of brightness. As a result, regions can be divided more appropriately than in the conventional techniques.

[0063] The inspection processor **160** of the printed circuit board inspection apparatus **100** (**FIG. 1**) compares a reference image of a reference printed circuit board PCB with no defects and a inspection image of a printed circuit board targeted for defect inspection, and to detect specific differences therebetween as defects of the target PCB. It is possible to execute the inspection only on the regions (e.g., gold plate regions) selected by the user as inspection targets, or only on the regions not selected by the user.

[0064] B. Second Embodiment

[0065] A second embodiment of the present invention is similar to the first embodiment, except for the method for calculating the composite distance index C(i ,j).