A new threshold segmentation algorithm for segmenting micro-focus X-ray BGA solder joint image

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Abstract. Grid Array Ball (BGA) has been used in the production of electronic devices and components because of its small size, high I / O port density and so on. However, BGA solder joint defects will reduce the performance of the motherboard. Because micro-focus X-ray BGA solder joint image has a large number of redundant defect detection information (such as line-bridge in BGA packaging device), we propose an image segmentation method based on the combination of the mean area value of independent connected region as the threshold and mathematical morphology. The results show that the proposed algorithm can separate the solder joint and the background successfully and realize the accurate segmentation of the joint area.

Introduction

BGA packaging is a new advanced integrated chip packaging technology, and widely used in the production of large-scale integrated circuits. But the solder joint defects affect the performance of the packaging device. At present, the common methods of solder joint defect detection are ocular estimating, flying needle electronic testing and X-ray detection. Ocular estimating method is difficult to determine whether the solder joints bubble rate of qualified and easily influenced by subjective factors while flying needle electronic testing has higher rate of false which the effect is very difficult to satisfactory. Therefore, the industrial use micro-focus X-ray on the solder joints defects in BGA package device [1].

Micro-focus X-ray [2] is a commonly used method of nondestructive testing, which has a great advantage in imaging resolution, magnification ratio, scattering attenuation, the detail identification and sensitivity. It has been widely used in the field of real-time imaging detection and industrial X-ray detection, especially in the surface mount technology (SMT) industry as an important means of printed circuit board (PCB) testing. At present, the research of X-ray BGA solder joint defect detection is mainly concentrated on: the BGA solder joint segmentation is realized by using global threshold segmentation in Literature [3]; the solder joint segmentation is accomplished by using the global threshold segmentation as preconditioning in Literature [4];complete solder joint automatic extraction by solder joint geometry information and iterative calculation to obtain the optimal threshold segmentation in Literature [5].However, the results of the segmentation of Literature [3,4,5] solder joints are not accurate, and the interference such as line bridge is still in existence.

This paper is divided into two parts:The first part is to propose a new segmentation algorithm. The second part is the comparison of the results of the common segmentation algorithm and the

proposed segmentation algorithm. Illustrate the effectiveness of the proposed segmentation algorithm.

The proposed algorithm

Empirical mode distribution

Image segmentation is a very important content in digital image processing. Image threshold segmentation algorithm one of the common segmentation algorithm because the simple principle, the small amount of calculation and the good segmentation effect. The determination of threshold value is the key to the whole threshold segmentation. Whether the threshold is reasonable or not directly related to the result of the segmentation, and the difficulty of the threshold segmentation method is the threshold. It can be seen from Figure 1, if the threshold selection is bigger, then the target is difficult to get accurately and is likely to be the background as a target. However, if the threshold selection is too small which will weaken the target properties, then as the background. It is difficult to deal with subsequent processing effectively and affect the result of judgment.

(a) (b) (c) (d)

Fig. 1 the images of different threshold segmentation

(a)the original image(b)segmentation image of appropriate threshold (c)segmentation image of too small threshold (d)segmentation image of too big threshold

The algorithm flow is as follows:

(1) Determining the threshold and threshold is defined as

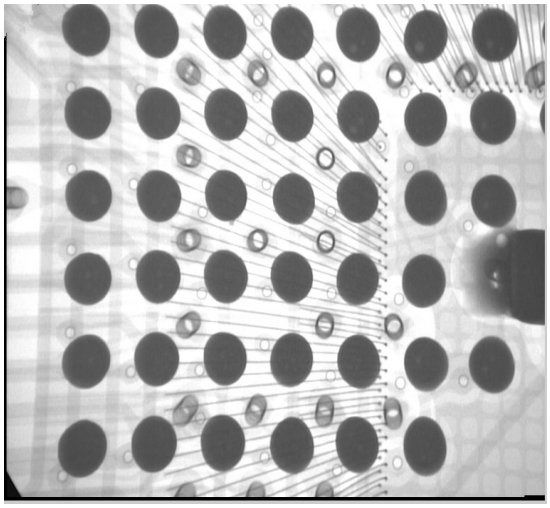
$$T = \frac{1}{N}\sum_{0}^{N-1} S_i \tag{1}$$

Where, N is the number of independent connected region and S_i is the area of the $i+1$ independent connected region.

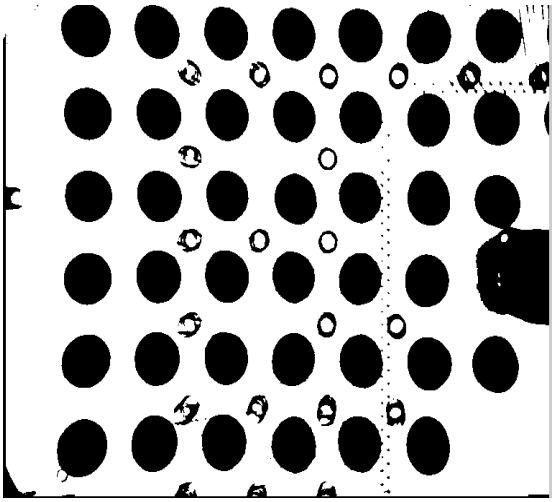
(2)The open and close operation of mathematical morphology is used to deal with it after get the binary images. The aim is to smooth its boundaries while not significantly changing its area.

Result comparison

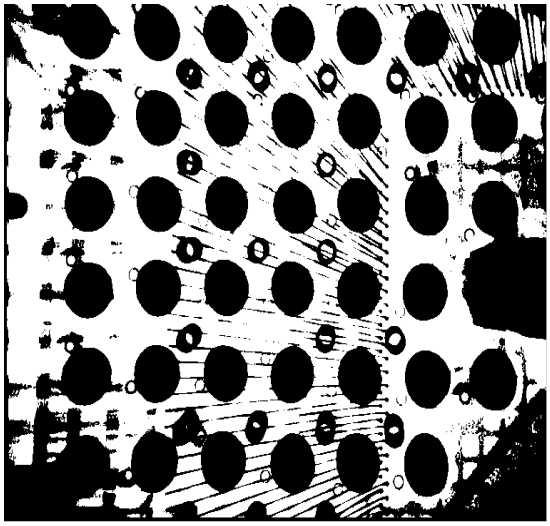
The common threshold segmentation methods have Otsu and the maximum entropy method, etc. The common edge detection segmentation methods are differential, LOG, Canny and so on. The common region segmentation algorithm has the region growing, the split and merge, and so on. Figure 2 is the segmentation results of several common segmentation algorithms and new threshold segmentation algorithm.



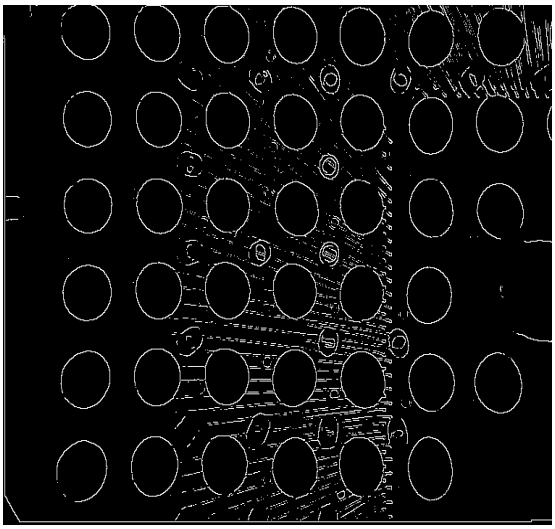
(a)



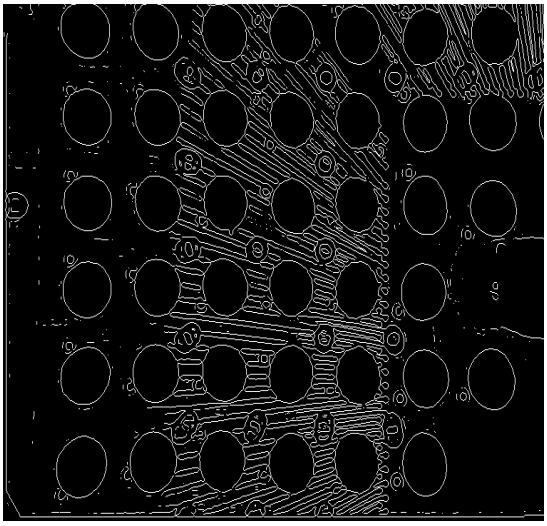
(b)



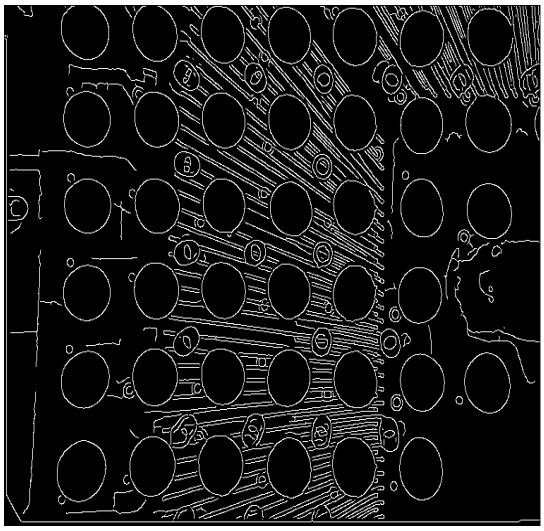
(c)



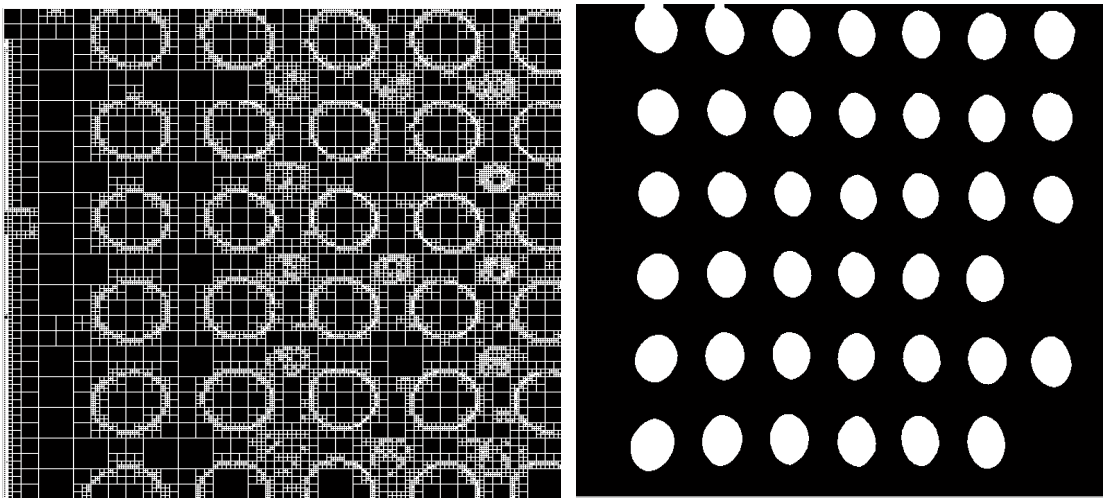
(d)



(e)



(f)



(g) (h)

Fig. 2 segmentation results

(a)the original image (b) Otsu (c) the maximum entropy method (d) Roberts (e) LOG (f) Canny (g) the split and merge (h) the proposed algorithm

The results shown in Fig. 2, the effect of the segmentation algorithm based on edge and region is the worst. In the threshold segmentation algorithm, the segmentation effect of Otsu is better than the maximum entropy method. But Otsu segmentation method still has interference.

Conclusion

In this paper, we first analyze the shortcomings of the existing BGA solder joint defect detection method, and then propose the advantages of micro-focus X-ray detection. Because many interference in the micro-focus X-ray BGA solder joint images, we propose an image segmentation method based on the combination of the mean area value of independent connected region as the threshold and mathematical morphology. The aim is to segment the solder joint area in the BGA solder joint image from the interference. Through Fig. 2 it can be seen that the new method algorithm not only can accurately segment the solder joint area, but also can effectively filter out the interference of the line-bridge and invalid solder joint. Make a great contribution to the next research.

References

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