Research on automatic arrange and detect system for plentiful immmethodical components

Zhang Kui¹⁻¹, Zhang Ru², Cui Yaru³, Zhao Hailong¹, Liu Huaguang¹, Ran Honglei¹, Yin Lijing¹
¹National Semiconductor Device Quality Supervision and Inspection Center, Shijiazhuang, China
²Hebei University of Science and Technology, Shijiazhuang, China
³Hebei College of Industry and Technology, Shijiazhuang, China
¹a Zhang Kui: test_tech@yeah.net

Abstract. With the development of electronic technology, the requirements for electronic components are gradually becoming chip, miniaturization and high precision. In this case, problems such as scattered sample parts and poor detection accuracy and stability in traditional production testing methods seriously affect production quality. Therefore, in-depth study of intelligent material discharge detection has become an important way to solve the problem. In this paper, the needs of intelligent detection are comprehensively analyzed, and the machine vision imaging optimization is deeply studied, feature matching and small sample capture placement technologies are learned. In order to realize intelligent discharge detection of micro scattered equipment, an automatic discharge system is developed, which integrates counting module, defect detection module and automatic discharge module.

1. Introduction

In the production test of electronic components, the state of samples in many links is scattered and disordered. At present, these plentiful immmethodical components should be arranged neatly in specific containers, acoustic scanning, X-ray, some electrical tests and other tests, as well as counting and visual inspection during handover, are performed before installation. It should be done manually.

Electronic components have the characteristics of small size, light weight, chip, miniaturization, high precision, etc., making the detection of electronic components increasingly difficult. According to the manual detection effect of small electronic components, it is easy to be affected by factors such as the fatigue of the tester, the amount of experience, and the quality of the on-site environment. It has the disadvantages of low detection efficiency and unstable detection. In addition, the production quantity of electronic parts is very large, and relying only on manual inspection will not only consume a lot of labor costs, but also cannot guarantee the accuracy and speed of inspection.

A detection technology based on computer vision and image processing technology is machine vision detection. It simulates the visual function of the object through a series of image processing software, and obtains useful information or features [1], thereby obtaining the image of the object and using it as the detection target.

Compared with human eyes, machine vision has the advantages of efficiency, precision, high stability, high speed, low cost, unlimited working time and information integration [2,3].
With the development of vision theory, the cost of realization is decreasing year by year. Therefore, it can improve inspection efficiency, reduce labor costs, and generate good economic benefits, with the development of an automatic inspection system for large quantities of disordered parts and the introduction of machine vision technology into the field of parts inspection for the first time. Machine vision technology can promote the development of electronic components and is of great significance to the development of inspection technology and the improvement of the level of automatic inspection.

| Test category       | Manual discharge detection | Machine vision discharge detection |
|---------------------|----------------------------|-----------------------------------|
| Efficiency          | Low                        | High                              |
| Speed               | Slow                       | Fast                              |
| Accuracy            | Ordinary                   | High                              |
| Reliability         | Instable                   | Stable                            |
| Working hours       | Limited                    | Can be continuous for 24 hours    |
| Information integration | Unrealizable       | Realizable                       |
| Cost                | High                       | Low                               |
| Environment         | Not suitable for hazard detection environment | Suitable for hazard detection environment |

2. Automatic layout detection requirements for plentiful immethodical components

The traditional unloading and product inspection methods are manual methods. However, with the increase of labor cost and the shortcomings of this method, the traditional manual layout inspection cannot meet the needs of modern production. Therefore, it is a general trend to study new methods to replace traditional manual nesting inspection methods.

In view of the unprecedented benefits of machine-vision detection in the development of machine-vision technology and the popularisation and improvement of related visual equipment, it has become the general tendency to use machine-vision technology for automatic emission detection [4]. However, in the current component detection field, there is no equipment on the market that can automatically discharge detection of various ex-situ components [5], so it is necessary to develop an automatic discharge detection system. This article develops an automatic discharge system for intelligent testing through an in-depth understanding of the component layout in the electronics industry. It meets the automatic layout requirements of many small method components, including automatic counting, automatic defect recognition and automatic discharge, etc., as shown in Figure 1.

![Figure 1. Requirements for automatic discharging of plentiful immethodical components](image-url)
Due to many electronic software have different appearance features and allround surface features and defect types. At present, the common image recognition methods in the market are difficult to solve the recognition and recognition problems:

1) In the same acquire environment, the results of different defect types are different. Sometimes, the acquisition condition which is good for one defect type is not suitable for other defect types;
2) The surface of defective extractive accurate is high, and the general size is mm. The accuracy directly affects the design of layout detection system;
3) Generally, the surface of components is engraved with characters, which increases the difficulty of obtaining and defect extraction. The existence of characters will also produce glossy defects.

All these problems will lead to difficulties in sensor imaging and machine vision, so that further targeted technical research and design is necessary.

3. Design of automatic material layout system for plentiful immethodical components

3.1. Overall architecture design
According to the requirements of sonic scanning, X-ray and some electrical tests, the discharge and installation of materials, and the sample count and appearance inspection involved in the sample transfer process before and after the test, the automatic discharging system for bulk disordered components is further divided into component counting module, visual inspection module and automatic discharging module component counting module, an appearance inspection module and an automatic unloading module.

The component counting module conscious the counting function of sample and store. The appearance inspection module realizes the function of appearance inspection of test samples, including archiving photos of components, identifying authenticity, screening dissimilarity and checking the appearance of test components. According to the machine vision test results, the self discharge module achieves the functions of sample installation before scanning, X-ray, electron microscope, sample preparation before electrical measurement, etc. The three modules are indispensable and closely connected.

3.2. Development of counting module
The camera mechanism and the calculation system constitute the component counting module, including industrial camera, light source and auxiliary mold, etc [6]. At present, there are two imaginable acquisition schemes: high definition telecentric camera and linear scanning camera.

According to the small size of parts, for example, the package size of 0402 is only 1 mm * 0.5 mm, the effective observation range is 150 mm * 200 mm, and each camera has at least 6 pixels, if the resolution of each camera exceeds 1 million pixels. Considering the low utilization, we need 8-10 megapixel HD cameras. Considering that some elements are thicker, only telecentric cameras can reduce the projection effect. The disadvantage is that the sample is easily affected by the projection.

The way a line scan camera works is similar to the way a mobile phone takes panoramic photos. The linear array camera is driven by the mechanical structure to scan the whole observation range, which can obtain high-definition, shadow free images before further processing. The disadvantage of this scheme is the high cost and the demand for machinery.

The system adopts linear array camera, which requires high precision and high labor cost.

The counting algorithm based on machine vision is adopted to complete the software, and the counting process is shown in Figure 2.
3.3. Development of surface defect detect module

Because the deep learning model of image classification and recognition needs a large number of sample data, through sufficient training, the sample features can be accurately extracted. Therefore, the sample size plays a key role in the entire process of training and learning. But so far, there is no public database of electronic component defects similar to ImageNet, so this paper needs to collect enough pictures [7].

Electronic components are widely used in many kinds. The defects of simplified components mainly include the following categories:

1) Defect
2) Scratch or scratch
3) Deformation
4) Rupture
5) Discoloration or blistering

Collect defect images based on product packaging and defect category. If the number of images collected does not meet the training requirements because the product is scarce, the following methods can be used to expand the number of samples to meet the requirements for the number of images in the training set:

1) Random rotation: randomly rotate the image by one angle.
2) Random clipping: local images in different positions can be obtained by random clipping.
3) Contrast Transformation: the contrast transformation factor is set randomly on the image, and the contrast of the image can be adjusted.
4) Flip transform: flip the image vertically or horizontally.

Since the collected images are all images without data labels, it is a very time-consuming process to manually label pixel level image segmentation. The Labelme tool is used to mark images, and the marked files are stored separately in a folder. In order to avoid the problem of inconsistent image size in training and occupy more video memory, it is necessary to compress the original image [8].

The final data set includes 10 kinds of different defect forms and 6 kinds of electronic component defect library with different packaging forms. The number of pictures is 1523, including 1211 defect pictures and 312 defect free pictures. After the completion of the data set, 200 random defect images and 50 random defect free images are selected as the test set to preliminarily test the recognition
accuracy of the trained convolutional neural network; the rest of the images are used as the training set to train the convolutional neural network.

3.4. Development of automatic discharging module

Scattered components face problems such as mixing of front and rear equipment, standing on the side, and stacking. To automatically discharge it, technologies such as automatic positioning, flipping, shifting, positioning and placement must be solved to achieve the installation and various test functions before sound scanning. X-ray test, automatic unloading and packaging after testing.

Based on the development of a machine vision system and a complex mechanical platform automatic unloading module, it can automatically complete the pre-arranged batch placement of components; it can determine the front and back of the material through machine vision, automatically locate the geometric center of the material, and reverse the bottom material. To ensure that the final orientation of the components is consistent. It can guide the robotic arm to grab the material and place it in the designated position through machine vision.

There are manifold samples and packages involved in component testing, such as SOT (small profile transistor), DIP (dual in line package), QFP (square flat package), etc.,

However, different methods are used for identification and automatic detection of packaging devices, so personalized automatic identification technology and automatic extraction technology are carried out for ordinary packaging, including the automatic identification of parts, the determination of positive and negative directions, and the automatic positioning, adsorption, clamping, rotation and turning of parts, etc.

A technical scheme of automatic turnover and layout of bulk disordered electronic components is adopted as shown in Figure 3. The automatic turning mechanism includes the first turning tray and the second turning tray. The linear CCD imaging device is set under the first turnover tray to obtain the image and position parameters of the electronic components on the first turnover tray. It has 180 degrees of freedom.

![Figure 3. Automatic turnover device](image)

The specific overturning method is as follows:

Step 1: establish the position coordinate system of electronic components.

Step 2: obtain the image of the electronic component on the first turnover tray, and obtain the shape and position parameters of the electronic component according to the image.

Step 3: obtain the image of each electronic component in the positive position, and calculate the center coordinate and offset angle of each electronic component in the position coordinate system according to the image of the electronic component.

Step 4: control the manipulator to grasp the electronic components and move them to the target position according to the center coordinates and offset angle of the electronic components to complete the regular layout of the electronic components.
Step 5: send an instruction to the automatic turnover mechanism, control the second turnover tray to fit with the first turnover tray, compress the electronic components reversed on the first turnover tray, and rotate 180 ° synchronously. The inverted electronic components are in the normal position on the second turnover tray. Repeat steps 3 to 4 to complete the regular layout of all electronic components.

4. **Effectiveness of intelligent arrange and detect system construction**
The establishment of automatic arrangement detection system for a large number of non-metallic components is shown in Figure 4. After testing, the system achieves the following performance:
1) Come ture the recognition, layout and counting of at least 8 kinds of packaging.
2) Discharging speed: < 10s / piece.
3) Discharging accuracy: 1 mm.
4) Maximum quantity of single batch identification: 500 pieces.
5) Counting speed: < 20s / batch.
6) Counting accuracy: was 99.99%.

![Figure 4. Automatic arrange and detect system for plentiful immethodical components](image)

5. **Conclusions**
In summary, the introduction of machine vision technology into the field of parts inspection for the first time can solve some of the drawbacks of traditional electronic component inspection methods. The main purpose of developing an automatic inspection system for large quantities of disordered parts is to improve inspection efficiency, reduce labor costs, and produce good economic benefits. Only by improving the development of detection technology and the level of automatic detection can it be better applied.

**References**

[1] Wang W C, Chen S L, Chen L B. A Machine Vision Based Automatic Optical Inspection System for Measuring Drilling Quality of Printed Circuit Boards. J. IEEE Access, 2017, 5: 10817-10833.

[2] Ardhy F, Hariadi F I. Development of SBC based machine-vision system for PCB board assembly Automatic Optical Inspection[C]. In: International Symposium on Electronics and Smart Devices, Yogyakarta, Indonesia 2017: 386-393.

[3] Raghuvanshi V, Burman A, Bartakke P P, et al. PCB solder pad inspection mechanism using gerber file[C]. In: International Conference on Communication and Signal Processing, Melmaruvathur, Tamilnada, India 2016: 1321-1325.

[4] Chen Z, Zhou D, Liao H, et al. Precision Alignment of Optical Fibers Based on Telecentric Stereo Microvision. J. IEEE/ASME Transactions on Mechatronics, 2016, 21(4): 1924-1934.
[5] Kuang Y, Li J, Liang J, et al. Research on Extracting Feature Points of Electronic-Component Pins[C]. In: International Conference on Intelligent Robotics and Applications. Wuhan, China. 2017: 611-622.

[6] Dr. Peter Mario Schwider. Following the CMOS Track: CMOS image sensors replacing CCDs in most applications. J. Optik & Photonik, 2016, 11(4):40-43.

[7] Silver D, Huang A, Maddison C J, et al. Mastering the game of Go with deep neural networks and tree search. J. Nature, 2016, 529(7587): 484-489.

[8] Belazzougui D, Raffinot M. Approximate regular expression matching with multi-strings. J. Journal of Discrete Algorithms, 2013, 18:14-21.