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# Application of Machine Vision in Automatic Optical Inspection System

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***ABSTRACT.*** *Electronic products with high density, fine spacing and low defect development direction have higher requirements for relevant detection technologies. The future is bound to be more general, efficient, precise and intelligent development direction. Based on optics and integrating information processing technology, computer vision technology, photoelectric technology and digital image technology, the image detection technology based on machine vision can meet the requirements of electronic product monitoring.*

***KEYWORDS:*** *Machine vision; Automatic optical monitoring system; Application*

## 1. Introduction

Surface mount technology is the most widely used electronic assembly technology in microelectronics assembly and manufacturing industry. It uses optical means to obtain the image of the printed circuit board to be measured by the automatic optical monitoring technology, which can automatically detect the optical quality of the optical circuit board by means of detection, analysis and judgment. After ten years of development, automatic optical detection technology in Britain, the United States, Japan, Israel, Ireland and other countries has entered a mature stage. However, China's related products are difficult to popularize in the relevant industries due to high price.

## 2. Concept and significance of machine vision

### *2.1 Concept of machine vision*

Machine vision is a new field of science and technology. It has developed rapidly in recent years. The main content of its research is to simulate the shape and macroscopic visual function of living creatures through computer vision. At present, it has become one of the key research directions in the field of computer science. In short, machine

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vision replaces the function of the human eye by using a machine to do the work of measurement and judgment. The basic working principle of a machine vision system is to convert the target into an image signal through machine vision products. After receiving the signal, professional image processing system converts the signal into a digital signal again based on the information of pixel distribution, color and brightness. After entering various operations of the image system, these digital signals extract target features and control the actions of field equipment based on the judgment results.

### *2.2 Application significance of machine vision technology*

Some professionals believe that all the monitoring that humans can do can be replaced by machine vision. Machine vision system can effectively improve the intelligence and automation of production, even some work that is too dangerous to be done directly by human beings. Machine vision technology can be used to perform tasks in working environments and occasions that cannot meet the working conditions of artificial vision. The application of machine vision monitoring technology can also greatly improve the production efficiency and automation level in mass industrial production. The feature of easy information integration makes machine vision become the basic technology of computer integrated manufacturing. It can quickly acquire and process a large amount of information, and at the same time, it can easily integrate the design information and processing control information, so that the machine vision system is widely used in the fields of modern automatic production monitoring, quality control, and finished product inspection.

### *2.3 Application of machine vision*

Machine vision has broad development and application space in many fields. The huge market demand can provide enough power for the research and development of machine vision system. For example, in China's microelectronics industry, which belongs to the emerging high-tech field, machine vision has only a small number of applications at the low end. The development of related technologies will inevitably lead to the urgent demand of machine vision system in all walks of life. The research and application of machine vision in the market demand guideline will be improved by leaps and leaps. In the future development of machine vision technology and artificial intelligence will be an important direction of work.

## 3. Basic concept and classification of testing technology for surface assembled products

As the development of microelectronics and electronic products in the manufacturing

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industry is gradually towards miniaturization, components will inevitably develop towards miniaturization and denseness in the future. At present, the most widely used technology of electronic assembly is surface mount technology. Most of the relevant equipment has been relatively mature in terms of production and application, but the testing equipment is still at the beginning of the market. Solder paste printing, component placement, reflow soldering, and monitoring of related production processes are all facing greater challenges due to factors such as future development trend of components, higher density and complexity of components on circuit boards, smaller components, and manufacturers' requirements for increased production. With the development of surface mounts technology, the existing detection methods cannot meet the needs of future development. In addition to the quality of raw materials, advanced production technology, advanced management mode and production equipment, the production and assembly of high performance, high quality, high complexity of microelectronics products also requires manufacturers must have advanced monitoring equipment and complete technical quality assurance system. The main testing methods adopted in the assembly line are as follows:

The first is the artificial vision inspection technology, which has been used for the longest time. The operators manually inspect the circuit boards with microscopes and circuit board overlays. Therefore, it is more suitable for the detection of small plates. However, the development trend of miniaturization of components and the increase in component production will inevitably lead to a sharp decline in the accuracy and reliability of manual testing. The high cost and the limitation of manual testing will inevitably lead to the elimination of manual testing technology;

The second is online testing technology, has developed a variety of mature testing equipment such as needle bed tester, flying needle tester. They can test the electrical performance of analog, digital and mixed signal components, and timely find out the components that do not meet the production specifications, effectively guaranteeing the quality of the final product. On-line monitoring technology can quickly conduct a short circuit and open circuit test on the internal circuit, and it is also very good for the economy of mass production. However, the application scope of this detection technology is very narrow, subject to the limitations of multiple directions, it is difficult to popularize.

In the middle and end stages of the production line, the functional modules of the circuit board can be comprehensively tested by special monitoring equipment to confirm the quality of the circuit board. This method is called functional testing. Able to test can be used with a variety of equipment, based on a specific version and a specific unit, is one of the earliest automated testing methods. However, this method is not suitable for low tin and virtual welding, and cannot detect the specific point of the problem. And the writing process of function test program is too complicated, so it is not suitable for most circuit board production line.

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In recent years, a new nondestructive testing technology for X-ray solder joint has been developed. Combined with computer image processing technology, the SMT solder joint, PCB inner layer and internal wiring can be detected with high resolution. X-ray detection technology is slow, expensive and difficult to program. It requires high technical level, and its application scope is limited, especially for some virtual welding and cold welding phenomenon is difficult to detect.

Automatic optical detection is usually used in online monitoring of mass production. This method captures images of devices on circuit boards or solder joints, and then uses software to determine whether the devices are perfect or not. The test results can accurately determine whether the components are missing, polarity reversal, Solder Bridge, solder joint quality and other problems. Under normal conditions, automatic optical inspection will be arranged after solder paste printing, before reflow welding and after reflow welding, so as to timely detect the defective products of various stations of surface patch technology. Compared with the final test, the cost can be reduced by ten times. Automatic optical detection technology USES computer image analysis "learning and comparison" technology in programming detection, which belongs to non-contact online monitoring technology. This kind of technology is easy to track and diagnose, easy to operate, simple to program, low production cost, no fixture, high defect coverage is preferred, and has been widely used abroad. The reliability of this technique is improved compared with other techniques in the past, and it can be used to detect the amount of tin in solder joints. Combined with SPC, the measured data can greatly improve the quality of products. However, automatic optical detection technology cannot detect the dry point covered by the components, in the short circuit, the current success rate is still very low.

In addition to the above five more commonly used detection technology, there are ultrasonic detection, laser detection and other detection technology. These methods are suitable for different conditions and occasions, each has its own advantages and disadvantages. With the development of computer and image analysis technology, automatic optical detection technology based on machine vision technology shows more and more advantages.

## 4. Main direction of future development of automatic optical detection equipment

### *4.1 Pattern recognition method will become the mainstream in the future application*

The automatic optical detection technology applied in the surface patch technology is mainly used for the detection of PCB circuits of various specifications and types, SMD components, components after assembly, solder paste printing images, etc., and the replacement of detection objects is very rapid, it is difficult to fully keep up with the corresponding design rules and standards. Therefore, it is difficult to apply DRC method

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based on design rules. The problem of high speed image processing has been solved with the rapid development of computer technology. Many kinds of automatic optical detection techniques of image recognition have been widely used in surface patch technology.

### *4.2 Developing intelligent automatic optical detection technology*

With maturity and popularization of surface patch technology, automatic optical detection technology will inevitably develop the intelligent direction. Due to the high density, miniaturization, rapid assembly and variety diversification and other development characteristics of surface patch technology, the amount of monitoring information is large and complex, and it is almost impossible to diagnose and analyze the information obtained by automatic optical detection technology by relying on manual work. The test results cannot be fed back in time, and the accuracy of the analysis and diagnosis cannot be guaranteed.

### *4.3 Embedded detection technology*

Automatic optical detection technology has been developed to combine with solder paste printing machines and placement machines to save money and space. The time used for testing is also effectively saved by the way of inspection at each station. The idea, confirmed by global instruments and Cyberoptics, is that the embedded detection technology will facilitate the widespread use of process monitoring technology in PCB assembly lines.

## 5. Development status of automatic learning inspection technology

Automatic optical detection technology has incomparable advantages compared with other detection methods. At the end of 1970s, some multinational enterprises in the electronics industry began to conduct research on automatic optical detection system, and invested a lot of manpower, material resources and financial resources. At present, the relevant technologies in the world are relatively mature, and the main manufacturers that can produce automatic optical detection systems include CAMTEK and Orbotech companies in Israel, Agilent in the United States, and Omron in Japan. In the production line of surface patch technology, automatic optical detection technology based on machine vision has been widely used at that time, although it has not been popularized. In the production line of surface patch technology, automatic optical detection technology based on machine vision has been widely used at that time, although it has not been popularized. In the current production practice, there are some problems such as high missed inspection rate and high false alarm rate. Many unqualified products have

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not been detected in time, and the solution of relevant problems still requires researchers to carry out a lot of theoretical research and practical application.

## 6. Conclusion

Foreign productions lines have begun to use automatic optical detection equipment, although the maturity of the technology is not compared with the printing press and the placement machine, many aspects still need to be improved. Meanwhile, automatic optical detection systems and products with independent intellectual property rights are still in their infancy in China. Although China now has a large number of electronic product production and assembly lines, there is still a long way to go in the research of optical detection system and products with independent intellectual property rights, which is of great significance to the development of related industries in China.

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