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THE INSPECTION QUALITY TO DETECT SCRATCH USING ROBOT VISION

[1]Rohani Awang Che Da, [2]Nabihah Mohd Nawi, [3]Durga Devi Jagathesan,
[4]Nurul Fatihah bt Mohd Azam, [5]M F Rajemi

College of Business, School of Technology Management and Logistics
University Utara Malaysia, 06010, Sintok, Kedah, Malaysia
Email: rohani9119@yahoo.com

ABSTRACT

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Automated Robotic vision helps to prevent quality problems from occurring. In this research, the concept and operation of robot inspection in fabricating the integrated circuit (IC) is being discussed comprehensively. The results showed the advantages and disadvantages of using this technology to further improve the quality of IC fabrication

Keywords
Robot inspection in fabricating integrated circuit (IC), Automated Robotic Vision,

Example:
Neural Network, Component-based

1.0 INTRODUCTION

Quality assurance in its broadest sense is any action taken to prevent quality problems from occurring. In practice, this means devising systems for carrying out tasks which directly affect product quality. In manufacturing industries based on assembly line where product quality is mandatory when production volume grows. Thus, the field of robotics and automations inspection is developing rapidly.

Robotic vision makes processes simpler, more straightforward and cutting costs. The benefits of sophisticated vision technology include savings, improved quality, reliability, safety and productivity. Robot vision is used for part identification and navigation. Vision application is generally deal with finding a part and orienting it for robotic handling or inspection before an application is performed

The purpose of robot vision is to enable robots to perceive the external world in order to perform a large range of tasks such as navigation, visual serving for object tracking and manipulation, object recognition, and categorization, surveillance, and higher-level decision making. Among different perceptual modalities, vision is arguably the most important one. It is therefore an essential building block of a cognitive robot.

2.0 LITERATURE REVIEW

2.1 Integrated circuits

Integrated circuits are tiny electronic circuits built to perform a particular function made of active and passive components such as transistor, diodes, and resistor. An integrated circuit, or IC is small chip that can function as an amplifier, oscillator, timer, microprocessor or even computer memory.

IC chips falls into numerous categories and types. Although many classification exist, the three primary classification are analog, digital and mixed-signal integrated circuits. Digital integrated circuits, primarily used to build computer system, also occur in cellular phones, stereos and televisions. Digital integrated circuits include microprocessors, microcontrollers and logic circuits.

Analog integrated circuits most commonly make up a part of power supplies, instruments and communications. Analog or commonly known as linear ICs work with continues values. In these applications, analog integrated circuits amplify, filter and modify electrical signals. Memory integrated circuit can be found in computer systems, cellular phones, stereos and televisions. Memory circuits store information, data as two number 0 and 1. All the data that access by electronic component will be stored fully in memory chip's data storage locations.

Integrated circuit is the smallest chip which is contain a thousand of transistor. When the process IC chip so many defects can be happen to the circuit board. To identify those defects and scratch automated integrated circuit inspection using robotics were carried out by manufactures. This known as one of the easiest way to detect scratch in

circuit board and help to simplify manufactures burden as well.

2.2 Importance of Integrated Circuit (IC)

In manufacturing industry, conventional human inspection causes errors in long term and monotonous processing, besides inducing tongue stress to human inspectors. In manual inspecting markings on Integrated Circuit Chips, an incorrect decision on marking may result in an appropriate placement of chip on printed circuit board during assembly process. Thus, automatic inspection of Integrated Circuit markings attracted considerable interest.

Besides that, during processing of the final work, the errors found in integrated circuits can be detected and it reduces all the problems faced by integrated circuits. This will give an advantage to companies which helps reduce the errors that arise during the delivery of the product to the customer, or when using the finished products.

2.3 The Uses of Integrated Circuit (IC)

2.3.1 Virtually Electronic Equipment

An Integrated circuit or IC is a set of electronic circuits on one small plate call "chip" of semiconductor material, normally silicon. Integrated circuits are used in virtually all electronic equipment today and have revolutionized the world of electronics. It is also known as the basic building component of all electronic circuit and systems. All the electronic devices depend on the integrated circuit's ability to store, process and transfer data and also transform electrical waveforms.

2.3.2 Single Components

The function of IC is to be a single component that can perform high level task. When using an IC saves the huge amount of space that the circuit would take up. It also help to saves a lot of electrical energy compared to the same circuit built using separate components. Another common but important application of this chip is scientific calculator which can perform basic mathematical function as well as complex function.

2.3.3 Numerous Categories or Type

Integrated circuit falls into numerous categories or types. The three primary classification of this chip are analog, digital and mixed signal integrated circuits. Analog integrated circuits amplify, filter and modify electrical signals. Examples of analog integrated system are power amplifiers, small signal amplifiers and microwave amplifiers.

2.3.4 Computer

Digital IC's are mostly used in computers. They are also referred as switching circuits' because their input and output voltages are limited to two level high and low. Digital integrated circuits include microprocessor, microcontrollers and logic calculation. They are used to perform mathematical calculation, direct the flow of data and make decision based on Boolean logic principles. Examples of Digital IC's are timers, flip-flops and logic gates.

2.3.5 Convert Digital Signals to Analog Signals

Mixed-signal circuits convert digital signals to analog signals, which in turn set the speed of motor and the temperature of heaters. It also convert digital signals to sound waveforms. Besides that, it will also convert analog signals to digital signals. They will convert analog voltage levels to digital number representation of the voltage level of the signals. Then digital integrated circuit will perform mathematical calculation on this number.

3.0 METHODOLOGY

3.1 Sensing

3.1.1 Intelligent Vision-Sensor for Robot- Sensing Applications

Robotic sensing is a branch of robotics science intended to give robots sensing capabilities, so that robots are more human-like. Robotic sensing mainly gives robots the ability to see, touch, hear and move and uses algorithms that require environmental feedback.

Vision is perhaps the richest human sense which allows us to perform a variety of tasks that would otherwise hardly be possible. Vision-based sensors used in a variety of applications are faced with the demand to transfer large amounts of information between the sensor and the processing algorithm. Recent advances both in computing hardware and semiconductor image sensors allow integrating image acquisition and signaling processing into a single sensor.

3.1.2 Image Processing

Image quality is important in applications that require excellent robotic vision. Algorithm based on wavelet transform for fusing images of different

spectra and different foci improves image quality. Robots can gather more accurate information from the resulting improved image.

3.1.3 Usage

Visual sensors help robots to identify the surrounding and take appropriate action. Robots analyze the image of the immediate environment imported from the visual sensor. The result is compared to the ideal intermediate or end image, so that appropriate movement can be determined to reach the intermediate or final goal (David Nit Zan, 1988)

3.2 Concepts of Automated Optical Inspection

Automated optical inspection (AOI) is an automated visual inspection of a wide range of product such as printed circuit board (PCB), LCDs, transistors, automotive parts, and integrated circuits (ICs). In case a PCB inspection , a camera autonomously scans the device under test for variety of surface feature defects such as scratches and stains, open circuits, short circuits, thinning of the solder as well as missing components, incorrect components, and incorrect placed of component. It is commonly used in manufacturing process because it is a non-contact test method. These inspection devices all have some common attributes, that effect capability, accuracy and reliability.

3.3 Operation of Automated Optical Inspection

A machine vision or an AOI system can acquire a million data point (pixels) in a fraction of a second. These data points are used for visual inspection and precision measurement.

AOI visually scans the surface of the PCB. The board is lit by several light sources and observed by a scanner or by a number of high definitions of cameras. This enables the monitoring of all areas of the board, even those hidden in one direction by other components. It should be noted that each manufacturer of AOI systems utilizes different inspection algorithms and lighting techniques, each of these systems may have varying strengths and weaknesses depending upon the item or product it is inspecting.

3.3.1 Light Sources

Lighting preprocesses the image to amplify features that need to be inspected and suppress noise. Advances in lighting have improved the capabilities of vision systems, in part by reducing the computation required by the vision computer. In other hand, the lighting combinations ideally will improve the image quality to improve the efficiency of the vision system decision making process. Most AOI systems will have predefine lighting combinations depending upon the mode of the operation and type of product being inspected, the system software or algorithms will manipulate and choose the best image for analysis.

3.3.2 Capturing and Image

If a scanner is used it has to scan the surface of the PCB from above only once, if image cameras are used, one must first determine the number of cameras needed. The cameras should be able to move in both X-and-Y-direction controlled by software to be able to scan the device from all point of view.

Each of industry is different in how image acquisition signals are transferred to the camera. It can be hardware driven via a mechanical signal such as a proximity sensor, laser interruption, drive system encoder position, or software. Regardless of the signal the AOI system interprets the signal which triggers the vision assembly which could be a single frame grabber and camera combination or more advanced that the object is in a known location and to begin image acquisition. The vision computer then triggers the cameras to simultaneously acquire images of the device.

3.3.3 Programming

The AOI system need time to know the object which in the PCB industry is typically a circuit board. Several method of learning from image matching and algorithm based. The vision machine needs to be able to add learned information acquired from the above inspection techniques to it memory. It has to remember the different types of components, their positions and also to check the quality of the soldered joints. It must be able to recognize and adapt to differences in the appearances of the board resulting from normal process variations, but must be able to recognize any that effect performance. To achieve this, it must run a number of good boards through the system before full production starts so that the system can learn the board.

3.3.4 Data Selection

3D software imaging or LED light measurement can be used to obtain the necessary data, which common method for measuring solder joint parameters. These systems use a directed light source or refracting light to measure height, area, and volume. The vision computer and its software analyze data and

calculate statistical process control (SPC) result in these areas. The results of the inspection are used to reject defective parts.

3.4 Advantages

3.4.1 Performing Flaw Detection

Robotic inspection systems are performing flaw detection on parts, ensuring complete part assembly, and measuring parts. Robotic inspection systems offer cost savings over traditional inspection solutions. Robotic inspection improves quality in manufacturing because robots can do inspection on every part rather than just on samples. Traditional quality inspection has only one or two percent of parts sent to a laboratory to be checked out. Quality and cost pressures drive robotic inspection.

3.4.2 Surface Finishes and Finding Precise Dimensions

When a bad part shows up, the system has to be configured to properly deal with it. Inspecting all parts rather than just a small sample is important to most end-users. Traditional inspection has some parts shipped to the quality department, where these parts are put into a coordinate measuring machine for a quality check. With robotic inspection, manufacturers can perform in-line quality checks. The advantage is that manufacturers can check every part rather than just one out of 100.Robotic inspection adds quality checks into the manufacturing process earlier, so end-users can stop adding value to a bad part and gets it off the assembly line sooner and more reliably.

3.4.3 Measure Items

Robots are also used to measure items. Inspection systems are measuring components but as tolerances of the measurements get tighter and tighter, these tolerances become harder to satisfy. Lighting and part presentation to the robot becomes more critical. When moving from verifying a part's presence to actually measuring it, we are adding complexity to the inspection system. As an example of robotic inspection, the vision system is ascertaining if a nut or a bolt is where it should be or that a hole is tapped properly. Those features should be inspected with robotics to increase efficiency.

3.5 Disadvantages

3.5.1 Prohibitive

While the benefits of machine vision sensors are substantial, the disadvantages of machine vision can be prohibitive. Machine vision systems are unable to cope with unforeseen circumstances and input. While ultimately cost-saving, high development costs can be expected for installation and personnel training. Constant levels of appropriate illumination can be difficult to maintain, and cameras can have difficulties isolating products in congested environments.

3.5.2 Lighting

When using a robot vision system for fault detection and dimension control, lighting is always a critical component and should be treated as one of the first steps of component selection. The effectiveness of an illuminating source in an inspection and fault detection process is determined by the direction at which light strikes an object and the direction of the reflected light into, or away from the camera. Suitable illumination covers the required field of view, creates a consistently measurable degree of contrast and does not cause reflected glare. Different light types are required to provide successful illumination for the broad range of products being inspected by automated systems.

4.0 FINDINGS

4.1 Material Handling

The IC chips are the fundamental building block and foundation for most of today's electronic systems. It is made up of active and passive components such as transistors, diodes, resistors and capacitors. These small IC chips not only reduce space in circuit board but also reduce power consumption and also cost of manufacturing. There many types of integrated circuits found in electronic components and should be handled accordingly.

Waffle trays are used to store IC chip safely. The waffle trays are according to IC chips various size and dimensions. Usually all the IC chip will load into Waffle trays or packs and this also identify as one of the traditionally popular method of storing bare die products. These trays are divided according to different IC chip measurement and prevent the chips from being damage.

Besides that, Horizontal Wafer Shipper systems provide secure protection for processing, storage and shipping of finished wafers. The system protects full thickness or thinned wafers from physical damage and electrostatic discharge and has low contamination characteristics, significantly reducing articulations, outgassing and Ionics. This system help chips from having any damage.

IC chips are easily damaged by heat when soldering and their short pins cannot be protected with a heat sink. Therefore manufactures handle this process by using an IC holder which is known as DIL- (Dual In

Line) which helped to soldered safely on to the circuit board. The IC will be push into the holder when all soldering is complete. IC holders are only needed when soldering so they are not used in breadboards. Usually soldering process done by a machine which is able to work very quickly.

Electrostatic discharge (ESD) is a single fast, high current transfer of electrostatic charge between two objects at two different electrostatic potentials. If this high current transfer exceeds the maximum rating of the fabrication process, obviously it will damage the IC. Therefore ESD protection such as ground straps, ESD resistant trays, tubes or wheel is most important when handling IC chip or transport it. The ESD protection enable IC chip to function well without any failure

A pin grid array (PGA) is a type of integrated circuit packaging. PGA is often mounted on printed circuit boards using the through whole method. PGA allows for more pins per integrated circuits than older packages such as dual line package. There are three types of PGA packaging such as flip chip, staggered pin and ceramic. A ball grid array (BGA) is a type of surface-mount packaging used for integrated circuits. This type of packaging provided more interconnection pins that can be put on a dual in-line or flat package. This processes help to produce a miniature package for an integrated circuit with many hundreds of pins. Both of packaging systems handle integrated circuit safely before end to assembly lines.

An IC chip testing process handle with automated vision inspection system. The vision system consist of standard CCD camera, a PC computer with data acquisition board, a customized six DOF robot, Scorobot ER-V robot and customized neural network software. The defects that can be identifying by this process are the quality of solder joint, excessive pin bend, and lifted or missing pin

4.2 Fully Automated PCB Assembly Line

The assembly line of Printed circuit board (PCB) is fully automated. PCB assembly is prototypes of medium batch production, where specializing in high density surface mounts assembly. The assembly line is fully automated and caters for a varied range of printed circuit boards from prototypes to medium batch production runs.

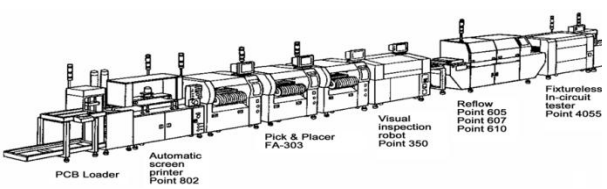

Figure 1: SMD Line Description

4.3 Product Transfer Line

4.3.1 Automated Production Lines

Automated production lines are divided in three sections. The first is fundamentals of Automated Production Lines, second is Applications of Automated Production Lines, and third is Analysis of Transfer Lines

Automated Production Lines also have a high production of parts requiring multiple processing operations and fixed automation. The applications are transfer lines used for machining, robotic spot welding lines in automotive final assembly, sheet metal stamping and electroplating of metals.

Where to Use the Automated Production Lines is, it have a high product demand that requires large production quantities, stable product design that have a difficult to change the sequence and content of processing operations once the line is built, for the long production life at least several years, and for multiple operations required on product which have the different operations are assigned to different workstations in the line.

4.3.2 Benefits of Automated Production Transfer Line

The benefits of transfer lines is low direct labor content, low product cost, high production rates, production lead time and work-in-process are minimized, and the last one is factory floor space is minimized

4.3.3 Automated Production for Transfer Line-Defined

Fixed-routing manufacturing system that consists of multiple workstations linked together by a material handling system to transfer parts from one station to the next. The slowest workstation sets the pace of the line or bottleneck. For the work part transfer it is palletized transfer line that uses pallet fixtures to hold and move work parts between stations. Then, for free transfer line it is the part geometry allows transfer without pallet fixtures

4.3.4 The analysis of Transfer Line

There are three problems areas must be considered. The first is line balancing, that which to divide the total work load among workstations as evenly as possible. The second on is processing technology, where the theory and principles about the manufacturing or assembly processes used on the line. Then the third is system reliability, that divided

into two cases transfer lines with no internal parts storage and transfer lines with internal storage buffers.

What the equations that can tell if lines with no storage buffers as the number of workstations increases line efficiency and production rate are adversely affected, and as reliability of individual workstations decreases, and line efficiency and production rate are adversely affected

4.4 Product Storage

There are many storage of PCB that we know. There are the different types of storage, storage for use or reuse and storage for disposal. Storage for use or re-use is keeping a PCB or PCB Item waiting installation, servicing, repair, refilling, use as a spare or replacement, or emergency use. Storage for disposal is storage of a PCB or PCB Item that is unfit for service, unauthorized for servicing or use, considered or declared a waste (a material on which PCB are spilled or released), or projected for disposal. However, the regulations for the two types of storage are inextricably intertwined. Thus, some PCBs and PCB Items stored for use or reuse must be stored under the same conditions as those stored for disposal.

Storage for reuse can be said that PCB article removed from service and stored for reuse could be stored indefinitely, without restrictions. The final rule has added a new section that specifically regulates PCS articles that are being stored for potential reuse.

PCBs, especially Multiplayer boards are extremely sensitive towards moisture The microscopic structure of the Multiplayer material develops a strong capillary power that soaks up the humidity of the surrounding air. Even under very dry conditions it is a question of time that water accumulates in the stored PCBs. For example, at storage conditions of 20 C and 35% of humidity the weight of the epoxy raisin of the Multiplayer PCBs rises, 0.12% due to the accumulation of moisture. If the capillary effect leads to an increase of more than 0.17 % a gas pressure of 8-10 bars can be reached, causing delamination. Even if delamination is made after production, the danger of the delamination can rise again due to unsafe transportation and on storage time. For the storage conditions, PCBs should be stored in heated and dry rooms. Constant low humidity is necessary before the soldering processes start. A rapid fail in temperature of more than 7 degrees causes consideration on the stored PCBs. Humidity should never exceed 65%. The package must be kept intact although the polyethylene packages capability of keeping humidity away is not really reliable.

4.5 Advantages of Integrated Circuit

An integrated circuit is a chip in that contains all the amenities of a normal circuit board. ICs are self-contained circuits with many separate components such as transistor, diodes, resistors and capacitors etched into a tiny silicon chip. Integrated circuits are the basic components of modern microelectronics. They are important process blocks in electronic systems. Integrated circuit was invented to solve the problems that were observed in discrete circuits. Now, IC become one of the important components in electronic products and brings great advantage to these products

The IC chip is in smaller size compare to discrete circuit. It makes this chip ideal for use in places where space is limited. Modern powerful computers can be built just because such ICs are available. The microprocessor of computers is an integrated circuit, and if it was made with discrete components, it would take up thousands of times more space. Due to fabrication of the various components became smaller and much lighter than discrete circuits. Thus it consumes less space in electric products. Therefore most of the IC chip is being used in PCB board to produce electric products.

The usage of integrated circuit help to reduce workmanship cost. This is because an inspection of integrated circuit can be done using robotic vision. Most of electrical industry applied robotic vision system to detect scratch in integrated circuit. The miniaturization of electronic components has increased circuit density and makes human assembly and inspection virtually impossible. Therefore Cartesian and SCARA robots are used to detect scratch accurately. The robot is used for loading and unloading the PCB board for automated visual inspection. The robotic visual system then determines if there are any defects on the board. When defects are found the robot will automatically place the PCB board on a conveyor for the further repairing process. By using the robotic inspection electric industry can detect scratch easily and able to produce quality products. These methods also help electrical industry to inspect many IC chip in short period and deliver to supplier on time. Nowadays, Robotic vision inspection using Scorobot ER-V and online monitoring is found to be a straightforward implementation and effective for electronic manufacturing industries. Although integrated circuit is in small size but it provides great benefits to electronics products around the world.

4.6 Disadvantages of Robot Vision

There are several disadvantages using these systems. First of all, robotic vision is a new technology and its uses and function have not yet been well

established. To date, mostly studies of feasibility have been conducted, and almost no long-term follow up studies have been performed. Many procedures will also have to be redesigned to optimize the use of robotic arms and increase efficiency of the product. However, time will most likely remedy these disadvantages.

Another disadvantage of these systems is their cost. With a price tag of a million dollars, their cost is nearly prohibitive. Whether the price of these systems will fall or rise is a matter of conjecture. Some believe that with improvements in technology and as more experience is gained with robotic systems, the price will fall. Others believe that improvements in technology, such as haptic, increased processor speeds, and more complex and capable software will increase the cost of these systems. Hospital and Health care center need to spend a lot of money to upgrade this system. Many believe that to justify the purchase of these systems they must gain widespread multidisciplinary use.

Another disadvantage is the size of these systems. Both systems have relatively large footprints and relatively cumbersome robotic arms. This is an important disadvantage in today's already crowded-operating rooms. It may be difficult for both the surgical team and the robot to fit into the operating room. Some suggest that miniaturizing the robotic arms and instruments will address the problems associated with their current size. Others believe that larger operating suites with multiple booms and wall mountings will be needed to accommodate the extra space requirements of robotic surgical systems. The cost of making room for these robots and the cost of the robots themselves make them an especially expensive technology.

5.0 DISCUSSION & CONCLUSION

Industrial vision systems must be fast enough to meet the speed requirements of their application environment. Speed depends on the task to be accomplished and may range from milliseconds to seconds or minutes. As the demands of processing increase, special purpose hardware is required to meet high-speed requirements. A cost saving feature of industrial vision systems is their ability to meet the speed requirements of an application without the need of special purpose hardware. PCs and workstations are nowadays fast enough so that this can be achieved in many application domains, especially in those with less demanding run time requirements.

IC chips falls into numerous categories and types. Although many classification exist, the three primary classification are analog, digital and mixed-signal integrated circuits. Digital integrated circuits, primarily used to build computer system, also occur in cellular phones, stereos and televisions. Digital integrated circuits include microprocessors, microcontrollers and logic circuits. IC also are being manufacture by manually and automatically. It also have their own advantages and disadvantages by using robot vision in production and process of Integrated Circuit.

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