ISSN (online): 2250-141X
Vol. 4 Issue 1, July 2014

A review on Automatic Bare PCB Board Testing

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ABSTRACT

A Printed Circuit Board is used to mechanically support and electrically connect electronic components using conductive pathways, track or signal traces etched from copper sheets laminated on to anon conductive substrate. The automatic inspection of PCBs serves a purpose which is traditional in computer technology. The purpose is to relieve human inspectors of the tedious and inefficient task of looking for those defects in PCBs which could lead to electric failure. This paper is a survey conducted on various existing approaches which performs automatic testing on PCB.

Keywords — embeddedsystem, pcb , image processing, mechetronics, testing, matching.

1. INTRODUCTION

Bare printed circuit board (PCB) is a PCB without any placement of electronic components (Hong et al., 1998) [12] which is used along with other components to produce electrics goods. In order to reduce cost spending in manufacturing caused by the defected bare PCB, the bare PCB must be inspected. Moganti et al. (1996) [11] proposed three categories of PCB inspection algorithms: referential approaches, non-referential approaches, and hybrid approaches.

- **Referential approaches:** It Consist of image comparison and model-based technique.
- **Non-referential approaches or design-rule verification methods**: This is based on the verification of the general design rules that is essentially the verification of the widths of conductors and insulators.
- **Hybrid approaches:** It involves a combination both of the referential and the non-referential approaches.

Due to the following criteria, the sophistication in automated visual inspection has become a part of the modern manufacturing environment.

- They relieve human inspectors of the tedious jobs involved.
- Manual inspection is slow, costly, leads to excessive scrap rates, and does not assure high quality.
- Multi-layer boards are not suitable for human eyes to inspect.
- With the aid of a magnifying lens, the average fault-finding rate of a human being is about90%. However, on multi-layered boards (say 6 layered), the rate drops to about 50%. Even with fault free power and ground layers, the rate does not exceed 70% [9].
- Industry has set quality levels so high that sampling inspection is not applicable.
- Production rates are so high that manual inspection is not feasible.
- Tolerances are so tight that manual visual inspection is inadequate.

A variety of approaches for automated optical inspection of printed circuit boards (PCBs) have been reported over the last two decades. This paper conducts a survey on various approaches already existing and the limitations still in automatic PCB testing are discussed in the following section.

1.1 SURVEY ON AUTOMATIC PCB TESTING

In the paper [1] Machine Vision PCB Inspection System is applied at the first step of manufacturing, i.e., the making of bare PCB. First they compared a PCB standard image with a PCB image, using a simple subtraction algorithm that can highlight the main problem-regions. The authors have also seen the effect of noise in a PCB image that at what level this method is suitable to detect the faulty image. Focus of this paper is to detect defects on printed circuit boards & to see the effect of noise. Typical defects that can be detected are over etchings (opens), under-etchings (shorts), holes etc

Syamsiah Mashohor et al [2] presents a novel integrated system in which a number of image processing algorithm are

ISSN (online): 2250-141X
Vol. 4 Issue 1, July 2014

embedded within a Genetic Algorithm (GA) based framework in order to provide an adaptation and better quality analysis with less computational complexity while maintaining flexibility to a broad range of defects. A specially tailored hybrid GA (HGA) is used to estimate geometric transformation of arbitrarily placed Printed Circuit Boards (PCBs) on a conveyor belt without any prior information such as CAD data. Their simulations on real PCB images demonstrates that the HGA is robust enough to detect any missing components and cut solder joint with any size and shape with significant reduction in computational time compared to conventional approaches

In the paper [3] presented a novel technique for PCB inspection based on the comparison of the Connected Table of a Reference and a Test Image. The method is based on connected component analysis, which is a natural way to extract the connectivity information of the conductors of a PCB. The registration of the PCB holes, which is a common problem related to referential model techniques, is solved by the concept of zone of influence of each hole. This paper describes the method and its implementation using standard Morphology Image Processing techniques. A result of applying the technique to real images was shown.

The authors Malge and Nadaf [4] proposed a PCB defect detection and classification system using a morphological image segmentation algorithm and simple the image processing theories. However, besides the need to detect the defects, it is also essential to classify and locate these defects so that the source and location of these defects can be identified. Based on initial studies, some PCB defects can only exist in certain groups. Thus, it is obvious that the image processing algorithm could be improved by applying a segmentation exercise. This proposal uses template and test images of single layer, bare, grayscale computer generated PCBs.

The study done by authors [5] proposed Bwlabel algorithm, used to deal with the PCB images under the condition of backlighting. According to the feature of Bwlabel algorithm extract and match the jack center indexes for every component, calculate the jack center connection angle, and generate jack center positioning data, figuring out the jack center coordinates. Combining with camera parameters, both the radial and tangential lens distortion are corrected, revising the coordinates of jack centers. At last, an automatic PCB jack positioning system is developed. The system experiment results show that the requirement of production has been met with accuracy of positioning that minimum jack diameter of 2.32mm and average time of 0.21s, which provides coordinates information for automatic assembly operation by manipulator.

In this paper [6], we represent a novel approach to the automated inspection of printed circuit boards. A model based on the coordinates and connectivity analysis of the circles is formed using some new approaches to edge linking, and fusion of some edge based and region based algorithms. A modified Canny edge detector is used as an edge based algorithm while an unsupervised learning algorithm is used to differentiate regions on the PCB. We have defined a membership function, which fuses the above two results. The edge linking algorithm extracts out the connectivity information for the circles using a new approach depending on making the decisions on fixation points.

Zuwairie et al [7] proposed the goal in their technique is to enhance the performance of the image difference operation in term of computation time using wavelet transform. The results of applying the technique to PCB images showed significant improvement on the traditional image differencing.

The paper [8] investigates methodologies for locating and identifying multiple objects in images used for surface mount device inspection. One of the main challenges for surface mount device inspection is component placement inspection. Component placement errors such as missing, misaligned or incorrectly rotated components are a major cause of defects and need to be detected before and after the solder reflow process. This paper focuses on automated object-recognition techniques for locating multiple objects using grey-model fitting for producing a generalized template for a set of components. The work uses the normalized cross correlation (NCC) template-matching approach and examines a method for constraining the search space to reduce computational calculations. The search for template positions has been performed exhaustively and by using a genetic algorithm. Experimental results using a typical PCB image are reported.

In the paper [9], a spatial filtering and wavelet-based automatic optical inspection system for detect PCB defects is presented. This approach combines wavelet image compression utility and spatial filtering. Defects are detected by subtracting the approximations of reference image wavelet transform and test image wavelet transform followed by a median filter stage. Finally, defect image is obtained by computing the inverse wavelet transform.

The paper [10] presented detection of faulty region of PCB by thermal image processing. Thermal imaging is used for analysis of thermal reliability of PCB. With variation in temperature fault can be detected. To detect faulty region, thermal image of a faultless PCB and faulty PCB is taken by the thermal camera and comparison is done for defect

ISSN (online): 2250-141X
Vol. 4 Issue 1, July 2014

detection. Here feature extraction is done with Principal Component Thermography (PCT). The Principal component analysis (PCA) applied on thermographic image data is called as Principal Component Thermography (PCT). The PCT used for processing IR sequences is mainly based on thermal contrast evaluation in time. The SVD computation technique is used in place of actual PCT to reduce the amount of computation that is needed. Then Euclidian distance is used to detect faulty region by comparing features. So faulty region is get detected.

A test jig [13] for probing single or double sided printed circuit boards ("PCB") containing targets statically retains the PCB in stable registration against a nest plate statically affixed to a main frame. A top frame with hinged cover, and a bottom frame are disposed above and below the main frame. Statically attached to the top cover is a top bed of nails and a clamp plate with through holes corresponding to targets on the PCB upper side. The bottom frame has statically attached thereto a bottom bed of nails whose probes can protrude through nest plate openings corresponding to targets on the PCB underside. The PCB is held statically and in registered alignment with the nest plate and during jig actuation, the top and bottom frames are moved vertically toward the PCB. Parallel aligned movement of these frames during actuation is ensured by mating alignment of main frame protruding guide rods and matching bushings affixed to the top and bottom frames. Registration between the top bed of nails, the nest plate and the bottom bed of nails is achieved by providing master tooling holes in these components (as well as the clamp plate). During setup, master tooling rods are passed through these holes, and the respective components are statically attached to the relevant frame. Because parallel movement of the top and bottom bed of nails relative to the statically retained PCB occurs, waffling, side loading and test probe damage are minimized, and the test probes make reliable contact with the intended PCB target.

1.2. LIMITATIONS OF EXISTING APPROACHES

The trend in Printed Circuit Board Assembly (PCBA) technology is towards higher complexity. A higher number of components typically mean higher cost for each PCBA, resulting in higher WIP cost (work in process) and scrap costs. Today's smaller components are also increasing the challenge to place them correctly on the PCB. Components such as 20 mil and 16 mil QFP's and 0402 and 0201 chip components are examples in this same category.

While using image processing based applications the Acquisition media like camera system which works under imperfect illumination conditions, the performance of the system doesn't produce satisfactory information due to smaller components resolutions are not accurate. Image difference operation is frequently used in automated printed circuit board (PCB) inspection system as well as in many other image processing applications. The inspection system performance depends critically on the speed of this operation, which is a common problem related to the image difference. If the image captured is not clear or else if the variation exists between the real and captured image the overall process turns to an erroneous conclusion. The position accuracy is still a challenging issue in the image processing based automatic PCB testing.

Limitation on jig method is Parallel components can only be tested as one component if the component is same, but different component in parallel connection sometimes can be tested for each component in different testing method. Electrolytic components can be tested for polarity only on specific configuration (e.g. if not parallel connected to power rails) or with specific sensor. The quality of electrical contacts can not be tested. It is only as good as the design of the PCB. If no test access has been provided by the PCB designer then some tests will not be possible.

2. PROPOSED WORK

An emerging issue for system designers is the desire to configurable products with a quick time to market. This has motivated designers to increase the adoption of programmable architectures. Thus the proposed work considers the drawbacks of the existing approaches and planned to overcome the issues in image processing based automatic PCB testing by planning to propose automatic coordinate detection in PCB using embedded approach with less human intervention and low cost consumption. In this system we access the machine through programs this based on mechetronics technology

- Flexibility to changes in the production process.
- Lower setup times for new products.
- Increase Productivity.
- Maximum utilization of production facilities.
- Less work in progress and reduced inventory.
- Increased profitability.

The above said points will be achieved by using Flying probe which does not require a fixture since the probes move around to all of the test points but in the existing approach namely Universal grid requires a fixture in order to conduct the test. Universal grid is sometimes called a clam shell or bed of nails test. In the flying probe an entire string of points or connections from the first source point to the last point including component lands and vias can be tested. The automatic testing can be done for any kind of PCB effectively and efficiently.

ISSN (online): 2250-141X
Vol. 4 Issue 1, July 2014

3. CONCLUSION

Electronic products have relied on printed circuit boards (PCBs) for their construction for several decades and there is no reason to believe that this is likely to change in the foreseeable future. As Systems and PCBs become more complex, with less physical access, the test model will need to look more like that of the IC. This paper surveys the various existing approaches of automatic PCB testing and the limitations still existing in this field. The proposal of the future work to enhance the above mentioned limitations are discussed.

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