Automatic Testing and fault Diagnosis System for Assembled PCB

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Abstract – Excellence of PCBS will have an important outcome on the performance of several electronic products. In mass-production of PCBS for electronics manufacturing industries challenge is made to achieve 100% excellence assurance of product. During the manufacturing of PCB various faults are presented which are damaging to precise circuit performance. The industrial environment contains various kinds for faults finding methods in the assembled Printed Circuit Boards (PCBS). Presently there are many test strategies are available for faults diagnosis in assembled Printed Circuit Boards (PCBS) for production line. Based on a wide literature review there were many methods available to determine faults,in most of the test techniques to inspect the Printed Circuit Board (PCB) based on manual visual inspection as well as image processing techniques. These all test strategies find faults in assembled Printed Circuit Board (PCB) without applying the signals. Usually, visual inspection of PCBS is done manually by inspectors. It is known that humans are subject to make mistakes, and they are slow and less reliable, so this paper aims to design and focus on developing a model to calculate the faults in a Printed Circuit Boards (PCBS) manufactured on a given assembly line, when we apply the signals to printed circuit board using embedded platform.

Keywords—Work in process(WIP),Printed circuit board (PCB), Image processing, Surface mount technology (SMT),Manual visual inspection (MVI), Visual inspection (VI), Functional test(FT),Device under test(DUT), Graphics user interface (GUI).

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I. INTRODUCTION

A Printed Circuit Board (PCB) is universally from a minor electronic system to a large electronic machine which we used in our daily life. PCB contains of circuit with many electronic mechanisms straddling on surface. There are more than fifty process steps required to fabricate a printed circuit board (PCB).PCB manufacturing contains of three phases in which examination of PCB essential to decrease the faults. First is lithography, second is component assembly over PCB surface and third is the component fusing. Printed Circuit Boards Assembly (PCBAs) are getting more complex day by day because of fast moving technology. Many boards have significantly more components and solder joints today than just a few years ago. A higher number of mechanisms classically mean higher cost for each PCBA, causing in higher WIP cost (work in process) and scrap costs [1]. Analyzing PCBs failure and their reason of failing is a challenging task but although how faulty they may be, they can be diagnosed and repair. PCB troubleshooting and fault investigation needs a good imaginary knowledge and systematic thinking [2]. To ensure quality, human operators simply inspect the work visually against prescribed standards. The decisions made by this workforce intensive, and therefore costly, procedure often also involve particular judgments. Automatic inspection systems remove the particular characteristics and provide fast, quantitative dimensional assessments. Machine vision may response the manufacturing industry's need to increase product excellence and upturn efficiency. The major restriction of current examination systems is that all the algorithms need a special hardware platform to achieve the desired real-time speeds. This makes the systems particularly costly. Any developments in moving up the computation method algorithmically could decrease the cost of these systems drastically. However, they remain an enhanced choice than progressively error prone, and slow manual human inspection.

II. LITERATURE REVIEW

Ambreen Insaf, Mirza Salman Baig, Zeeshan Alam Nayyar and Mirza Aman Baig[2] describe in their investigation on methods to classify and test PCB faults with proposed result. In a PCB mechanisms mounted are different groupings such as series, parallel or mix parallel or series groupings. It is difficult to identify the marks of these combinations. Therefore, in such cases the best solution is to associate the mark of imperfect PCB with well-known decent PCB. If the marks of the same pins are matching then there is no fault at that point. However, if the marks of the same pins are different then consider it as an indication of fault Jae H. Shim, Hyung S. Cho, and S. Kim[3] "An Actively compliable Probing System" A new probing mechanism and an related active compliance control algorithm have been developed for in-circuit test of a PCB (printed circuit board). Commercially available robotic probing devices are incapable of controlling contact force generated when a rigid probe contacts with a solder joint at high speed. This uncontrollable excessive contact force often makes some defects on the surface of the solder joint, which is plastically deformable over some limited contact force. This force also makes unstable contact motions resulting in unreliable test data. To overcome these problems, we propose a serially connected macro and micro manipulator equipped [4] with active compliance capability for safe and reliable in-circuit test. Moreover, with this probe the depth of penetration onto a solder joint [6] can be regulated after contact. This article describes the design characteristics, modeling [5], and control scheme of the newly proposed devices. The comparison of conventional passive compliance and force feedback control methods with the proposed control scheme for the contact force control is presented. In [7],[8] proposed the idea in Image Processing Based "Automatic visual examination method for PCBs". The on-line or automatic visual inspection of PCB is mainly a very first examination before its electronic testing. This examination consists of mainly absent or mistakenly located components in the PCB. If there is any misplaced electronic component then it is not so damaging the PCB. But if any of the component that can be located only in one way and has been fused in other way around, then the same will be damaged and there are chances that other components may also get injured. To escape this, an automatic visual examination is in demand that may take care of the misplaced or mistakenly located electronic components. In the existing paper work, an automatic machine vision system for examination of PCBs for any misplaced component as likened with the systematic one has been proposed. The system mainly consists of two parts: 1) The learning method, where the system is skilled for the systematic PCB, and 2) Examination process where the PCB under test is examined for any misplaced component as likened with the systematic one. The projected system can be deployed on a manufacturing line with a much more affordable price associating to other commercial examination systems. Automatic optical inspection (AOI) systems are widely approved in industrial applications. In PCB examination, AOI systems are used to detect surface-related defects such as bare-board examination, solder bridging, lack of solder, missing components, poor part orientation, lifted leads, tomb stoning, solder balls, and etc. [6].

Heriansyah, et al. [11], [12],[13] proposed a technique that classify PCB defect using neural network. Neural networks have been successfully implemented in many areas, including image processing and pattern recognition related problems.

Neural networks are good for adaptive pattern classification because they are easier to train and to use as compared to the traditional pattern classifiers. This algorithm segments the images in to basic primitive patterns. Enclosing the primitive pattern, pattern assignment, pattern normalization and classification where developed using binary morphological image processing and learning vector quantization (LVQ) neural network. In this approach to training and testing the neural network, 11 imperfect patterns have been designed. The designed pattern was in 8 x 8 pixels size, with the binary format. The PCB defects could be formed into three groups: the defects on the foreground only, the defects on the background only, and the defects on both foreground and background (the defect is caused by interaction with other object). To classify the defects, the LVQ neural network has been selected as the classifier. The designed patterns are trained and tested using this neural network. For the neural network implementation, only two groups of defects will be used for training (i.e. the foreground and the background). For performance comparison, a pixel-based approach developed by Wu et al. was used. At the time of writing this paper, this was the only algorithm designed for defect classification.

III. PROPOSED WORK

A. Scope:

Automatic Printed Circuit Board (PCB) testing machine is used for the testing of assembled PCB in mass production of particular product. The proposed system is to overcome the existing system for assembled Printed Circuit Board (PCB) testing system. In the existing system the numbers of workers are for the testing of assembled Printed Circuit Board (PCB) to test whether the Printed Circuit Board (PCB) is PASS or FAIL to work .If FAIL to work then where is the problem arises? Where the tracks are not available, where the dry solder are available, any resisters are with different value, how much current is available at test point, how much voltage at output side, etc. all have to test. But the time required for this procedure is too much. To overcome this time consuming process with optimizing the man power the system is proposed which will test the following parameter,

1. Voltage at input side as well at the output side,
2. Voltage at different test points,
3. Functionality test,
4. Wave form at different test points.

All these test points result will compare with standard result and will save the report in GUI Unit and also gives the LED indication PASS or FAIL. The total process of testing will complete within 5-10 minutes. If PCB is FAIL to work then the proposed system will saves the report where will the fault arise.

B. Methodology

In the total working schematic, there are five main units a) Mechanical Fixer Unit, b) Wire Wrap Board unit, c) Power Supply Generator unit d) GUI Unit, e) Micro-controller Unit.

Mechanical fixer unit: - The mechanical fixer unit is here to fix the DUT (Device under test) with the test point of PCB (DUT) connecting to buds of test point on the base of mechanical fixer unit so the Printed Circuit Board (PCB) under test will not move during test.

Wire wrap board unit: - The wire wrap board unit holds the wrapping of wire between buds of test point on the base of mechanical fixer unit signaling port. The need of wire wrap board is to mediator of signaling port and mechanical fixer unit at a distance place.

Power supply generator unit: - The power supply generator unit is here for providing required supply for PCB (DUT).There is no need of external power supply to connect to Printed Circuit Board (PCB) under test.

GUI unit:-GUI is a Graphical user interface in which we can design the figure depends on our purpose and requirement to implement our aim by designing GUI and its program we can put our ideas and also execute the operation of our ideas.

In which we can include various operations such as arithmetic, logical and so on because of that we can verify outputs of our operation. GUI is a toolbox which is very easy to handle and understand the user can easily interface with it, so the name given that the Graphical User Interface. In this model the GUI is the main object which plays a vital role. A graphical user interface provides the user with a familiar environment in which to work. This environment contains pushbuttons, toggle buttons, lists, menus, text boxes, and so forth, all of which are already familiar to the user, so that he or she can concentrate on using the application rather than on the mechanics involved in doing things. However, GUIs are harder for the programmer because a GUI-based program must be prepared for mouse clicks (or possibly keyboard input) for any GUI element at any time. Such inputs are known as events, and a program that responds to events is said to be event driven.

The GUI Unit in the PC shows following parameters

1. Input Circuitry,
2. Voltage at Test Point,
3. Functionality test.

Microcontroller unit: -The microcontroller unit is main part of whole system. All the controlling and processing functions are done by this unit. Following functions will be carried out by microcontroller. When Function key is operated the microcontroller unit displays the functions like Selection Mode, Start, Stop, ESC etc. Mode can be select to activate type of waveform generator which is to be providing to PCB under test.

1. Analog
2. Digital.

The START function is to start the system to Work STOP function is to stop the system to work. The ESC function is to abort the system to work. The Printed Circuit Board (PCB) under test is fixed in mechanical fixer unit and when system is started to work the microcontroller will read the resistance value without proving the power supply to Printed Circuit Board (PCB) which is under test. Microcontroller will give the signal to power supply generator unit and waveform generator unit.

The wire wrap board will provide the signal to buds of test point which is mounted on base of mechanical fixer. The test point from mechanical fixer unit will give signals from test point of Printed Circuit Board (PCB) under test to microcontroller through wire wrap board and ADC. Microcontroller will process on the received signal from ADC and will calculus the voltage, current value and saves the reading in GUI at respective Test Point; at the same time output waveform will displays on GUI Unit.

If the calculated reading and standard readings are matches approximately then microcontroller will give LED indication as PASS. If readings are not matches approximately not then will give indication as FAIL.

IV. SYSTEM HARDWARE DESIGN

As we have to work for proposed idea as given in block diagram. For this purpose, First of all we have to develop a hardware platform for proposed System. System hardware designing is divided in to three sections 1) CPU Board, 2) Input Board, 3) Wire Wrapping Board.

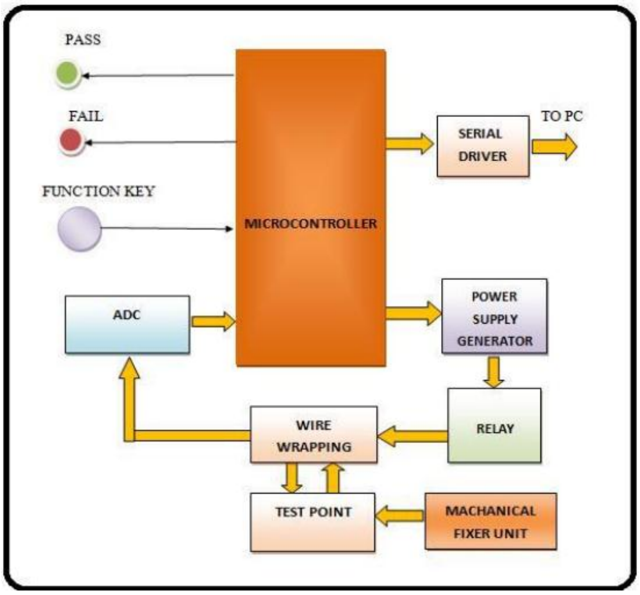

Fig.1. Block diagram of system

A. CPU Board Designing:

In this model we are using 16F877A micro-controller as CPU. 16F877A microcontroller requires some extra supporting hardware like + 5 volts power supply, MAX 232 IC and RS-232 serial communications. PIC 16F877 is one of the most advance microcontroller from microchip. This controller is widely used for experimental and modern applications because of its low price, wide range of applications, high quality, and ease of availability. It is ideal for applications such as machine control applications, measurement devices, study purpose, and so on.

B. Input Board

In INPUT board we have following parameters to design

1) Powers supply

2) Relay Driver card

In this model all devices are connected at the power supply terminals. For driving the relay we want +12 VDC supply, opam base adder we want +12/-12 VDC supply. Also for micro-controller board need +5vdc supply .so we had taken this Supply from the output of the rectifier.

There are total 12 test points therefore we have to drive 12 relays. Now we can't connect the relay directly to the micro-controller, because micro-controller board operates on + 5Vdc supply and relay operates on +12 VDC supply. Therefore to drive the relay we have to use high-voltage, high-current Darlington transistor array IC i.e. ULN2803A.

C. Wire Wrapping Board

Wire wrapping is a method of creation electrical networks for a circuit as a substitute to soldering. It is often used for prototyping but is also found in some types of marketable electronic equipment. Generally it employs per board (also called vector board), a circuit board with a grid of pre-drilled holes surrounded by solder pads. Components are injected through the holes, tack-soldered to the pads to hold them in place, and connected to each other by wrapping stripped wire around the pins. It is a simple and reliable way to build a circuit that doesn't require much technical knowledge and can be done with simple hand tools.

The fundamental component of this process is the wire wrap tool. This tool resembles a mini screwdriver with a round shaft. It has a hollow center at the end that a component pin can fit through. It also has a parallel hole on the edge which holds the wrapping wire which will wind around the pin in the center hole. Unlike soldering, wire wrapping requires extra-long pins so that a wire can be wrapped

D. PCB designing

For designing the PCB we had used Design Spark PCB software. This is operator friendly and very simple. Design spark PCB is free professional PCB design software, enabling electronic design engineers to take their designs from concept to production. The system is built on an integrated design environment providing all the tools required capturing a schematic through to the design and layout of the printed circuit board (PCB).We made the PCB layouts in this software.

V. SYSTEM ALGORITHM

1. Initialization of system.
2. Initialization of LCD.
3. Press the process button.
4. Initialization the counter.
5. Check counter value lass than total test points, then go to step no six.
6. Switch the respective test point relay.
7. Send test point value via respective relay to ADC pin of PIC microcontroller.
8. Display the respective test point value in to LCD.

9. Load this value in to array.

10. Check counter value if it is less than assign value then go to step no fifth other go to step no eleven.

11. Send all test point value stored in to array to GUI.

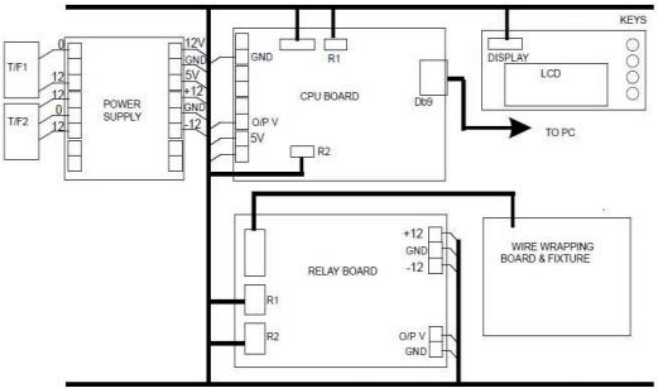

Fig.2. Wire Wrapping Board

VI. SYSTEM FLOWCHARTS

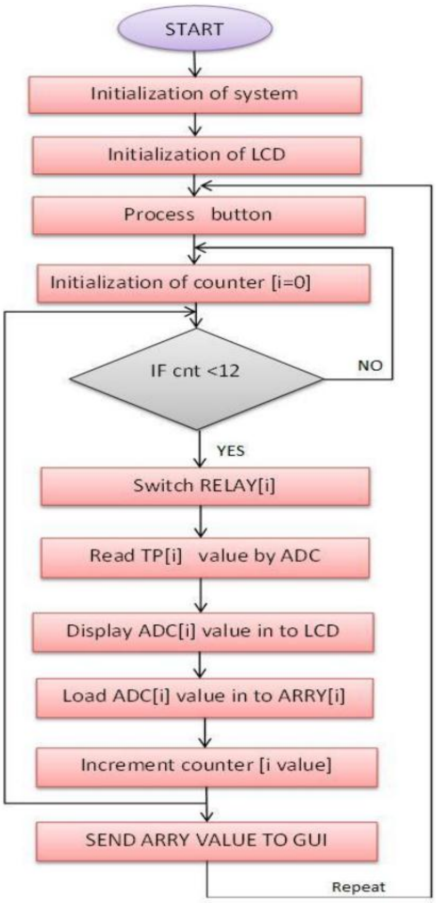

Fig.3. Flowchart

VII. SYSTEM RESULTS

Figure 4 shows the Graphics User Interface (GUI) panel. This Graphics User Interface (GUI) is used for analyzing Printed Circuit Boards (PCBs) failure. So Graphics user Interface (GUI) displays different test point's values which are to be tested for assembled Printed Circuit Boards (PCBs).

Figure 5 shows the limit editor window in Graphics User Interface(GUI).In this Window, operator enters the minimum limit and maximum limit of particular test points and save these values, so automatically data base will create in Graphics User Interface(GUI).These standard values will be given by Device Under Test(DUT) designer. So based on these values, system will find the locations where these faults occur in Device under Test (DUT).

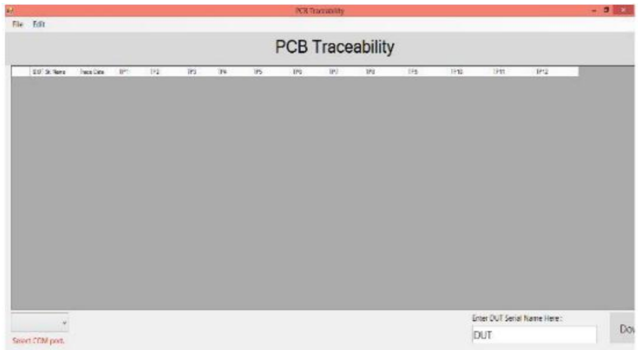

Fig.4. Graphics User Interface Window

Figure 6 shows the result window of system. This window shows the values of particular test points of Device Under Test (DUT).These values are transmitted by microcontroller unit to Graphics User Interface (GUI).In this window, green block Indicates no fault occurred at test points in our Device Under Test (DUT) and red block indicates fault occurred at test points in our Device Under Test (DUT).Green indication means your test point values are in limit and red indication means our test point values are out off limit. These indications are based on the data base values saved in our Graphics User Interface (GUI).

CONCLUSIONS AND FUTURE SCOPE

The proposed system performs automatically through embedded platform, for testing and fault diagnosis of assembled PCB system in production line, against conventional manual system of small and medium scale electronics manufacturing industries with following additional features as

- Human error has been minimized.

- The proposed unit cost is minimum as compared to existing test bench.

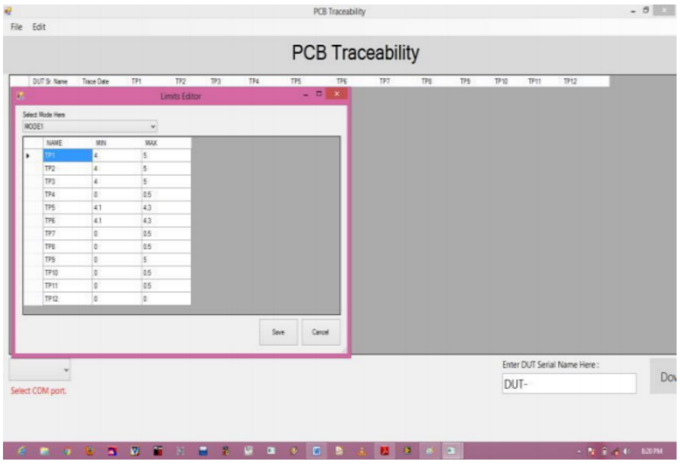

Fig.5. Graphics User Interface limit editor Window

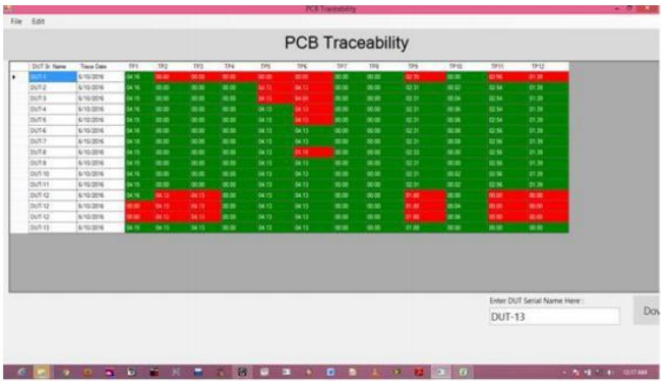

Fig.6. Graphics User Interface Result Window

- Testing and fault diagnosis time has reduced up to seven times as manual one.

- Productivity of production line is increased by three times as conventional.

In this model data acquired using this setup consisting of the micro-controller unit, relay interfacing card, Device under test (DUT) and Graphics user interface (GUI) is currently being implemented.

This model is used to find the fault only in static systems. Testing and fault diagnosis may be extended to dynamic nature for the same working environment.

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