

Bare and Assembled PCB Inspection through Graphical User Interface

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Abstract: The nature of the defects present in the Bare and Assembled PCBs are entirely different and also the algorithms used for the inspection of these two boards are not common. However, the inspection of both Bare and Assembled PCB has some commonality such as image pre-processing, etc. The main objective of this paper is to develop a common Graphical User Interface so both of these algorithms can reside in the same computer resource and can decide based on the type (bare or Assembled) to identify the defects.

Keywords: Printed Circuit Board, Bare PCB Defect, Component and Solder joint defects, Graphical User Interface.

I. INTRODUCTION

The Bare PCB mainly contains land pattern of the components and the connection among the components footprint present in the board via copper tracks. The land patterns of the components are represented by the number, size and type of pins present in the respective components. The pins of the component are known as pad stack and it may be through hole pin or SMT pin based on the type of the component. Hence the bare PCB includes only copper tracks Holes and Pads. The defects occurring in the Bare PCB are related to tracks, holes and pads only. The Bare PCBs are manufactured in PCB fabrication industries. The fabrication industry also performs the testing of Bare PCB before sending it to the PCB Assembly for placing the component. In PCB Assembly industries, the components will be placed on the Bare PCB using either manual process or computer programmed robotic machine based on the type of the components. The Assembled PCBs are inspected after the component placement in order to identify the defects related to component placement and amount of the solder applied to attach the component to the board[1-6]. Section II of the paper discusses the methodologies of bare and assembled PCB inspection Section III discusses the results obtained and performance analysis. Finally, conclusions are drawn.

II. METHODOLOGY

The methodology contains three parts: Graphical user interface development for the inspection of PCB, Bare PCB inspection and Assembled PCB inspection. The development of GUI is presented in subsection II A, Bare PCB defect detection model is presented in subsection II B and finally assembled PCB defect detection model is presented in subsection II C.

A. Design of GUI for PCB Inspection

The Graphical User Interface is designed to perform the inspection of both Bare and Assembled PCB. The selection of Bare PCB or Assembled PCB is performed using ComboBox component of the GUI. The main window of the GUI (Frame) is named as Inspection of Bare PCB and Assembled PCB and is divided into two panels such as input window and output window as shown in Fig. 1. In input window, one ComboBox component is attached in order to select the type of the PCB through two combo items such as Bare PCB and PCBA as shown in Fig. 2. Next, two buttons are added to select reference PCB and Test PCB. Browse and display of the image is performed when these buttons are pressed. The ProgressBar component is added to show the status of the execution of the back end algorithm. The test PCB image with highlighted defects is displayed in the output window after the execution of the algorithm. The procedure for creating the GUI for PCB inspection is as follows

1. Create a Frame with specific name and size
2. Divide the main window into Input and output panels
3. Add the buttons to select the type of the PCB-Bare PCB or Assembled PCB
4. Add the buttons to select the reference and test PCB
5. Add the button to run the corresponding algorithm (selects as per #3)
6. For every button define the action to be performed

The Bare PCB inspection is carried out by selecting the type as Bare PCB, Selecting reference and tests PCB and finally clicks on run button as shown in Fig. 3 to Fig. 4. Once the run button is pressed the control goes to back end and select and execute the Bare PCB inspection algorithm and display the output image in the output window as shown in Fig. 5.

Similarly, for assembled PCB inspection is carried out by selecting the type as PCBA. But for assembled PCB inspection, the template of every component present in the board is also selected along with reference and test PCB as shown in Fig. 6 to Fig. 8. Hence one more button is added here to indicate the count of the component. Again based on the count of the component, numbers of buttons are added to select the template of every component. Finally press the run button to perform the inspection of Assembled PCB. Once the run button is pressed, the control goes to back end and select and execute PCBA inspection algorithm and displays the output in the output window as shown in Fig. 9 and Fig. 10.

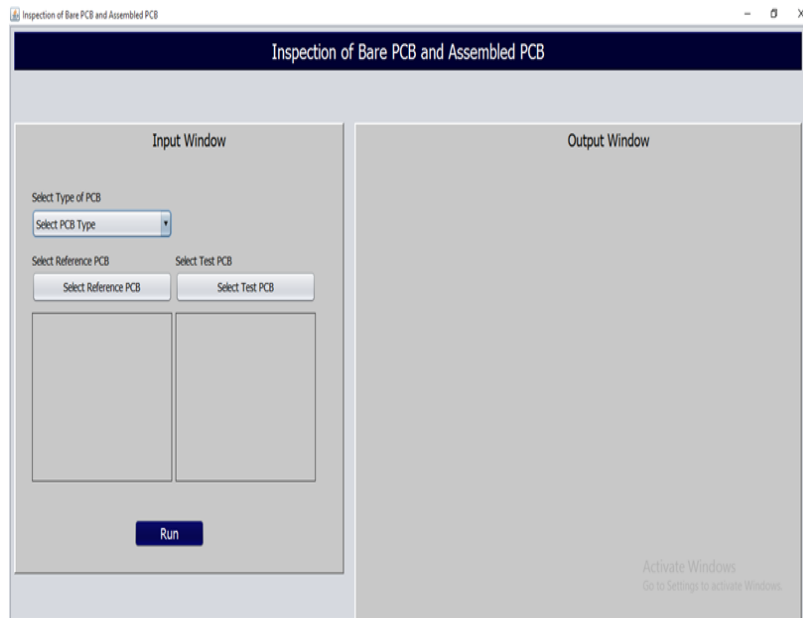


Fig. 1 The main window of GUI for PCB inspection.

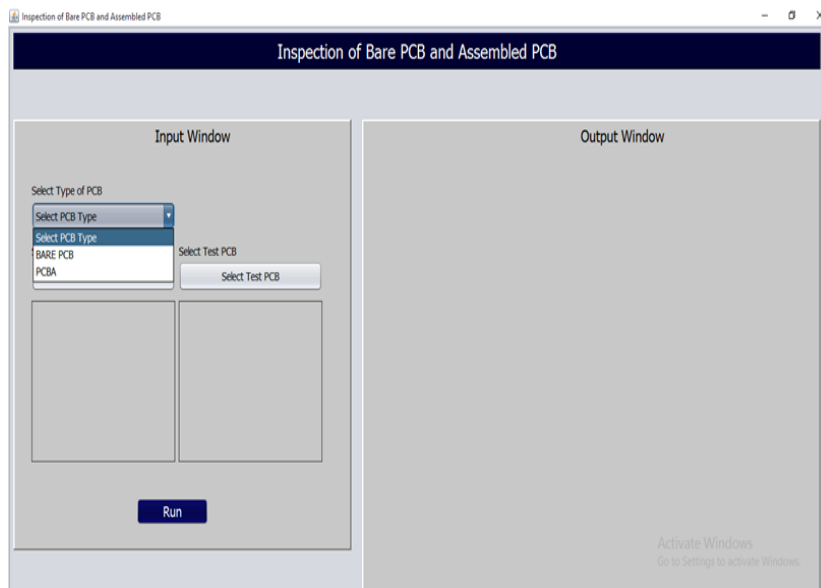


Fig. 2 The selection of type of PCB in input window of GUI

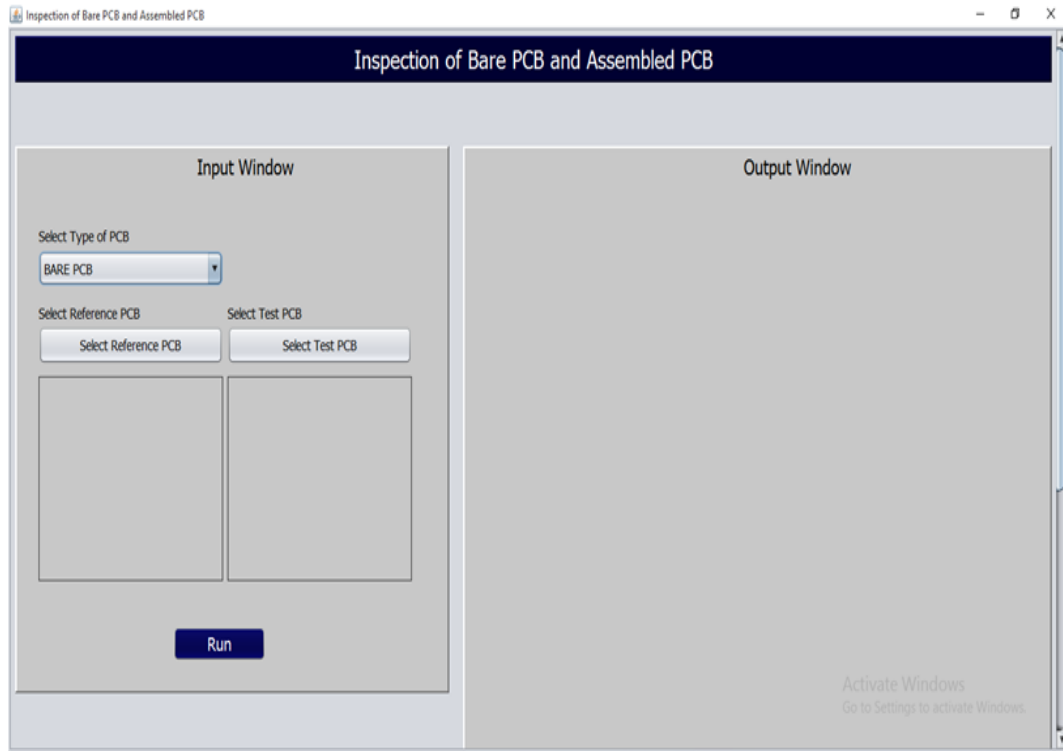


Fig. 3 The selection of Bare PCB in input window of GUI

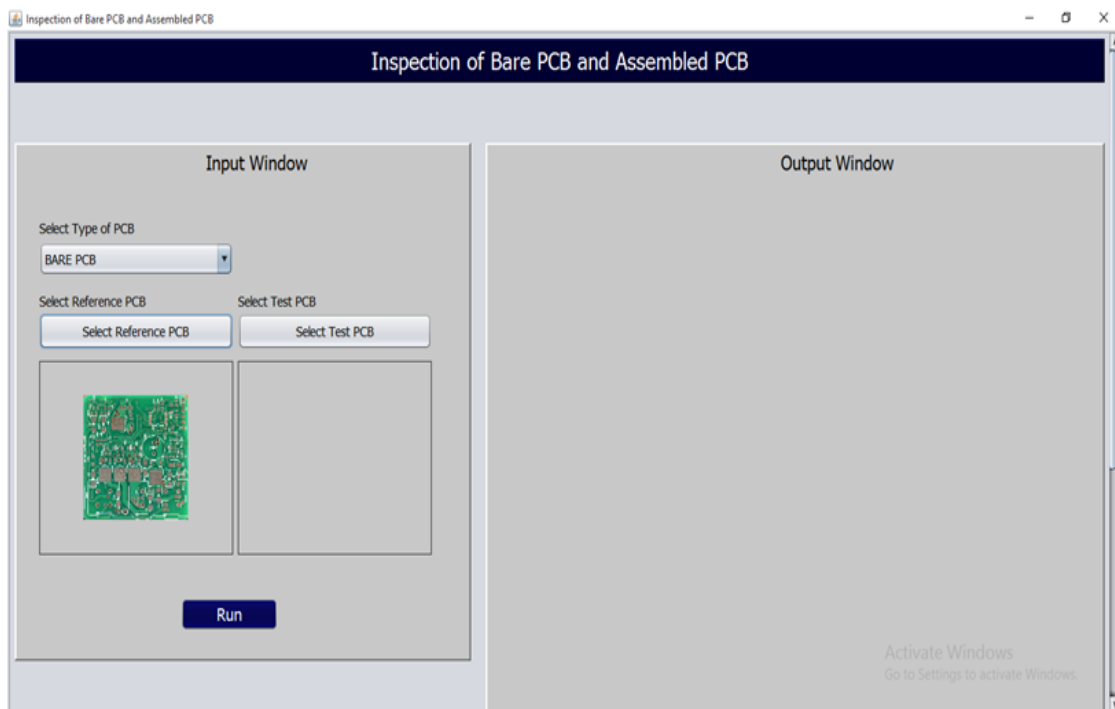


Fig. 4 The selection of reference Bare PCB in GUI



Fig. 5 The selection of Test PCB and run button in GUI.



Fig. 6 Output of Bare PCB inspection in output window

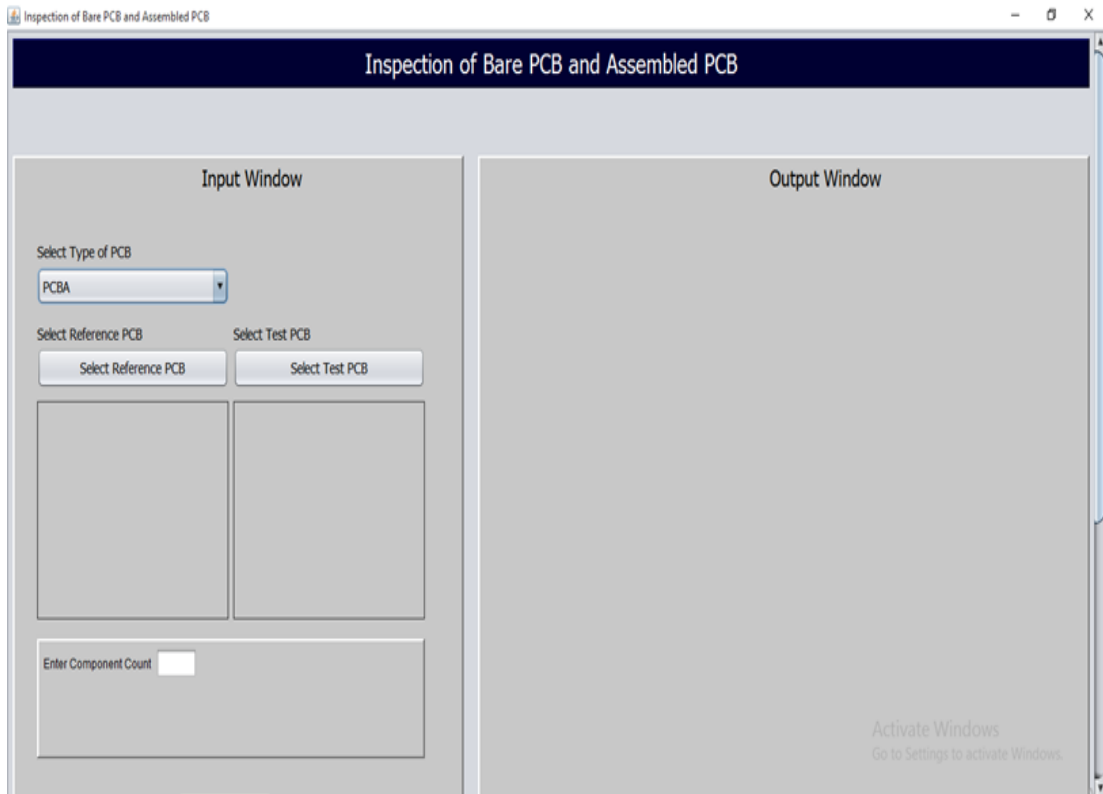


Fig. 7 The selection of Assembled PCB in input window.

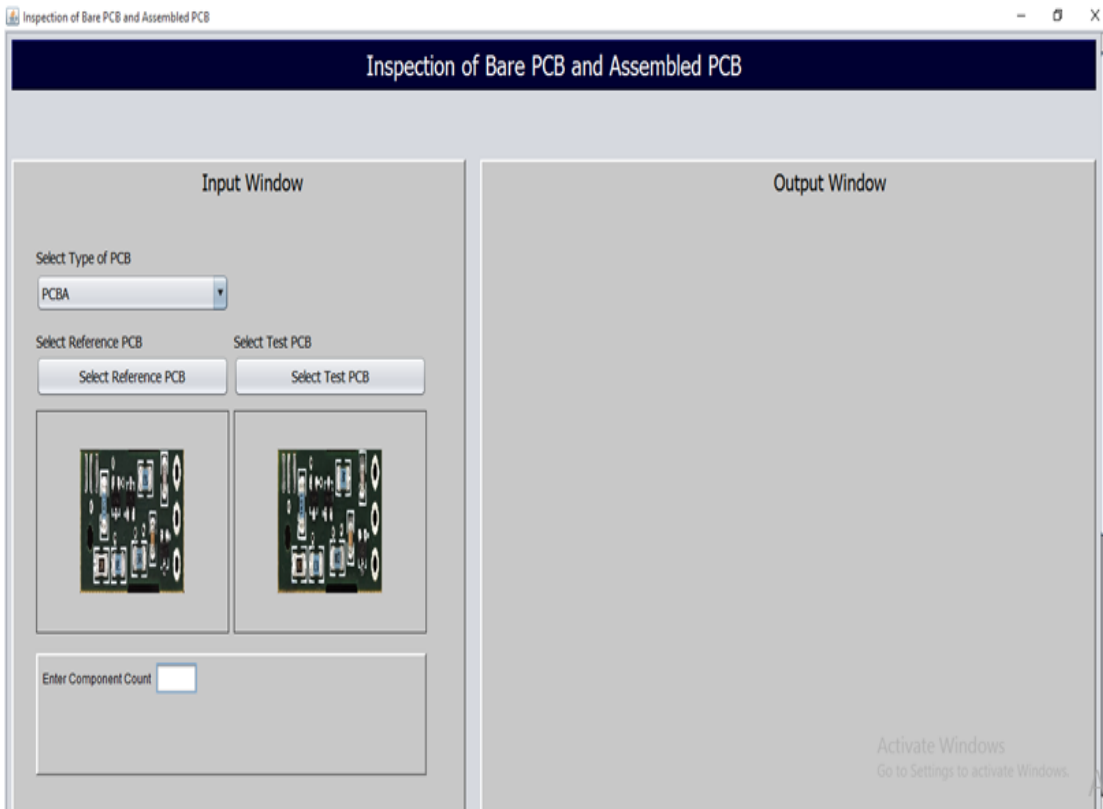


Fig. 8 The selection of reference and Test PCBA

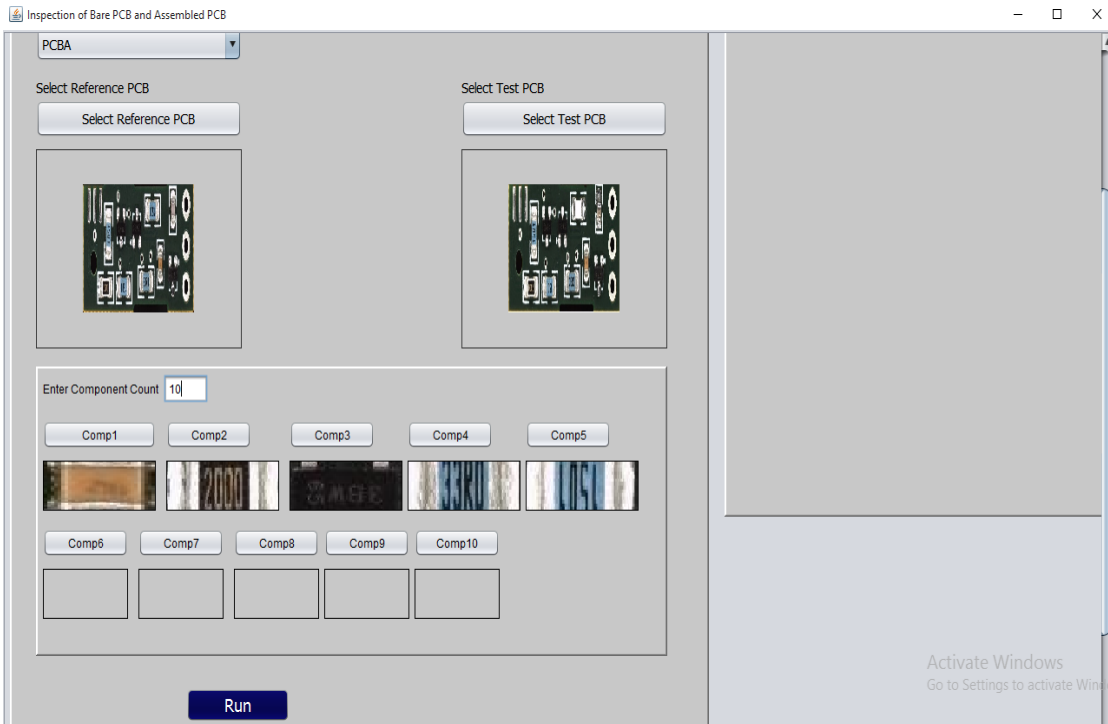


Fig. 9 The selection of every component of PCB.



Fig. 10 The output of Assembled PCB inspection

In this work, GUI is developed using Java NetBeans IDE 8.2 software shown in Fig. 11. The front end (GUI) of the PCB inspection is developed using Java and back end (Inspection Algorithms) is developed using python software. The inspection algorithms and their results are explained in next subsections.

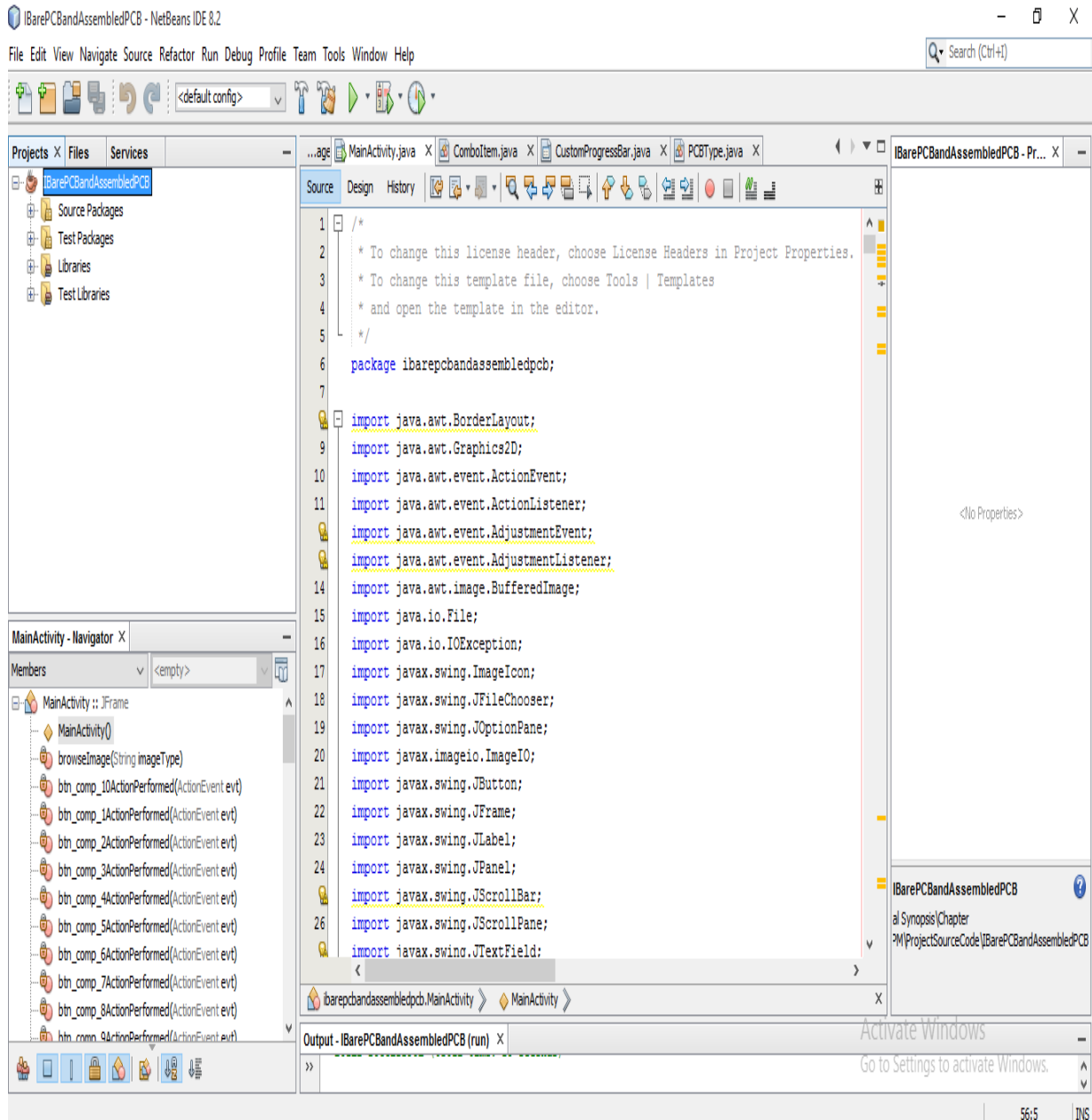


Fig. 11 NetBeans IDE 8.2 software window

B. Bare PCB Inspection

The block diagram of bare PCB inspection is as shown in Fig. 12[7]. The inspection Algorithm includes the following steps.

1. Acquisition of reference and test bare PCB image
2. Bare PCB feature extraction by processing the individual bands of RGB
3. Defect identification using thresholding operation followed by Image difference operation
4. Extraction of information about the location of the defect using Difference of Gaussian and Max filter
5. Localize the defect along with the label in the test PCB image

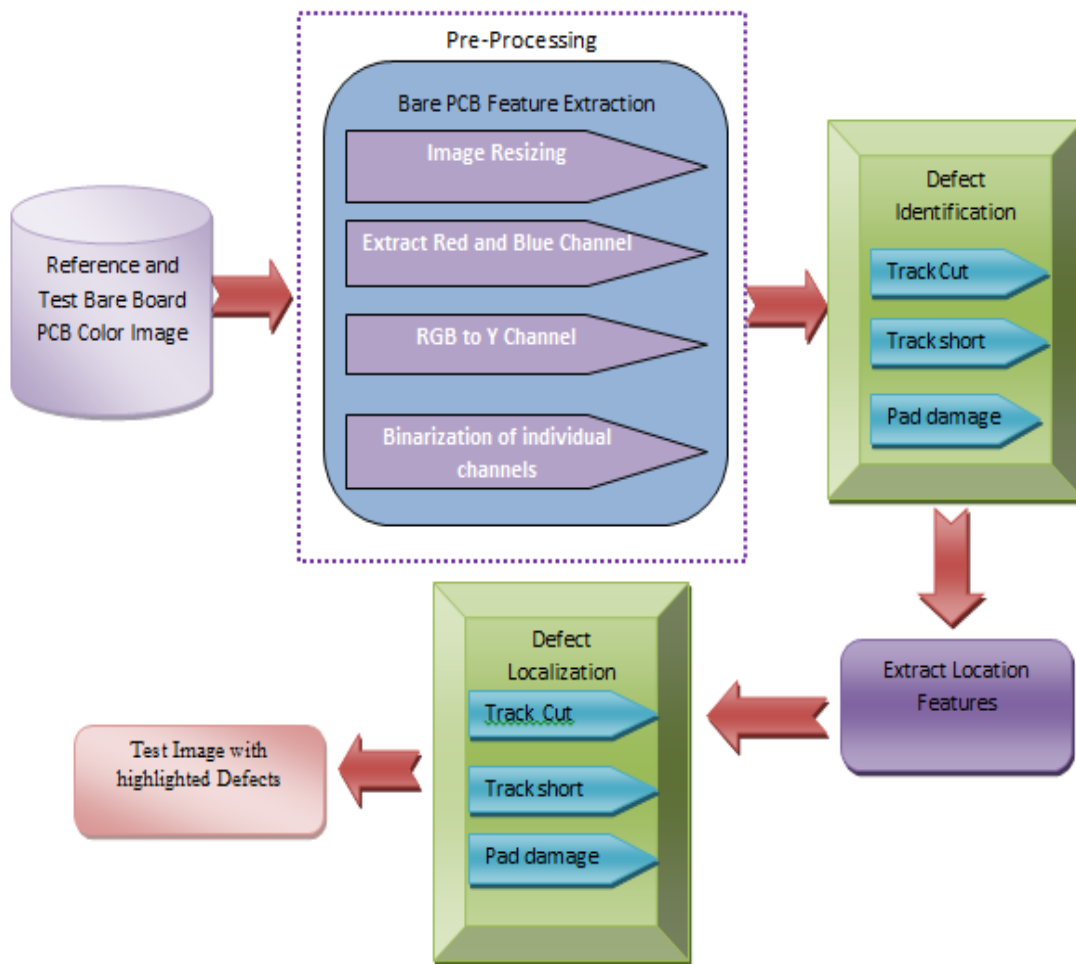


Fig. 12 Block diagram of the Bare PCB Inspection

C. Assembled PCB Inspection

The assembled PCB contains two types of component: SMT component and Through hole component. In the assembled PCB defects are related to the number of components present in the board [8-11]. The flow of Assembled PCB inspection algorithm is as shown in Fig. 13. The inspection algorithm contains the following steps.

1. Acquisition of reference and test Assembled PCB Image
2. Extract the ROI of individual component present in the reference board.
3. Obtain the statistical features of each component of both reference and test PCB.
4. Defect identification by the comparison of the statistical feature
5. Defect localization using the coordinates of the ROI.



Fig. 13 Proposed Model for assembled PCB Inspection

III.RESULT ANALYSIS

The inspection of both bare and assembled PCB through the development of GUI is checked and the results are obtained. The accuracy of inspection and time taken for the individual process is represented in the TABEL I to III

TABLE I INSPECTION RATE AND TIME FOR DIFFERENT SCALING FACTOR

Input PCB Image	Detection Rate in %	Recognition Rate in %	Inspection time	
			Individual type defect localization	Combined defect localization
Full Scale	100	100	1.6 minutes	32 sec
Scale downed to 2048x2048	99	99	24 sec	8 sec
Scale downed to 1024x1024	98	96	6.2 sec	2.2 sec
Scale downed to 512x512	97	96	1.7sec	0.7 sec

TABLE II ACCURACY OF INSPECTION FOR INDIVIDUAL TYPE OF DEFECTS

Name of the Defect	Total Number of defects	Number of defects detected	Accuracy of detection
Pad Damage	42	40	95.23%
Track Cut	48	46	95.83%
Track Short	48	47	97.11%
All	138	133	96.76 %

TABLE III TIME TAKEN FOR INDIVIDUAL PROCESS

Sl. No.	Operation	Time taken in msec.
1	Reference Image read & preprocessing (one time process)	102.32
2	Test Image read and preprocessing	102.32
3	Track cut defect recognition & localization	508.36
4	Track short defect recognition & localization	508.36
5	Pad damage defect recognition & localization	508.36
Total time including one time process		1729.72
Total time excluding onetime process		1627.40

IV. CONCLUSION

The Bare Board PCB inspection is carried out to identify faults related to copper tracks, SMT & TH Pads since the bare PCBs are mainly characterized by copper tracks, Holes and SMT & TH pads. But the inspection of assembled PCB is carried out to identify the defects related to the component placement and solder joints of the component. Assembled PCBs are mainly characterized by the types and nature of the components present in the board. Process is that the Bare PCB is manufactured by different organization and Assembled PCB is by different organization. Obviously the inspection process of Bare PCB and Assembled PCB will differ, however, some of the image processing procedures and process will be the same. Hence in this research work inspection of both Bare and Assembled PCB is performed by combining the two algorithms and running them based on the User GUI selection. So, the same Hardware and Software can be installed and a GUI to indicate which category of PCB and run the Software accordingly to inspect the PCB board.

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