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Circuit Extraction Technique from Perfboard Images

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ABSTRACT

Extraction of circuit from printed circuit boards (PCBs) helps in analysing the circuit which is complex. Currently there are many software that help use create a circuit so as to design it as the PCB but there is no software that does the reverse process[1-4]. Human identification becomes more difficult and mistakes occur as the perfboard has more components and fine connections in them.

In the proposed method the perfboard is converted into a matrix form both the front and back image and using backtracking algorithm the connections are established between the identified components and the solder weather it's in series or parallel. The results obtained where significantly faster and accurate in analysing the circuit designed on a perfboard.

Index Terms: Local Binary Patterns, Cascade training, Backtracking, Minimum hit rate and Maximum False Alarm Rate.

1. INTRODUCTION

Computer-vision plays an important role in automation not just in industries but also in our day to day life such as self-driving cars, inspection for PCBs in manufacturing industries, face detection for security purposes and so on. Image processing helps speed up the process and also avoid human error as well as.

Digital image processing is a stems from two principal application areas: the first being the Improvement of pictorial information for human interpretation and the second being the Processing of a scene data for an autonomous machine perception [5]. Digital image processing has a broad range of applications such as remote sensing, image and data storage for transmission in business applications and industrial automation.

Errors are most prominent when human beings are involved in an experiment. The goal of this project is to improve interaction with digital circuits and to reduce errors by reducing human interaction with the experiment and increasing human observation. For optimal results, machine vision should be implemented and precise calculations must be made[6-8].

2. ACQUISITION OF IMAGES

Initially the top view of the board is acquired (front image) which have the components facing them and back image which is exposing the solder part in the image and the back image is flipped horizontally so that the coordinates are same corresponding to the front images.

Before creating the matrix from the back image the front and back image are checked if the image size is same else it's resized so there is no error in correlating the connection of the circuit.

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3. IDENTIFICATION OF COMPONENTS

Local Binary Patterns (LBP) is used in the detection of the component where hundreds of positive and negative images were used to train the cascade. Considering the false positive rate as 0.5 the training went through 20 stages of cascade training.

The test circuit is designed on the perfboard using just four resistors. On accruing the top view and bottom view of the perfboard and passing through the initial manipulation the front image is passed along with the cascade that is trained which would result in identifying the component.

4. CREATING THE REFERENCE MATRIX

From the acquired back image of the test circuit a reference matrix is being created where each co-ordinates indicates the holes on the board. This reference matrix is first created for the back image. This matrix will be the same for the front image as well since the connections should be correlated with the components. As the reference matrix is created the values are set as 1 for the back image.

Now to identify the non-soldered points coordinates the matrix values will be set to 0. In this method the matrix is being updated.

5. IDENTIFYING THE NON-SOLDERED POINTS

For identification of non-soldered points in the images the Hough Circle Transform is detected from the back image and the identified location in reference to the matrix is being updated with the matrix as 0.

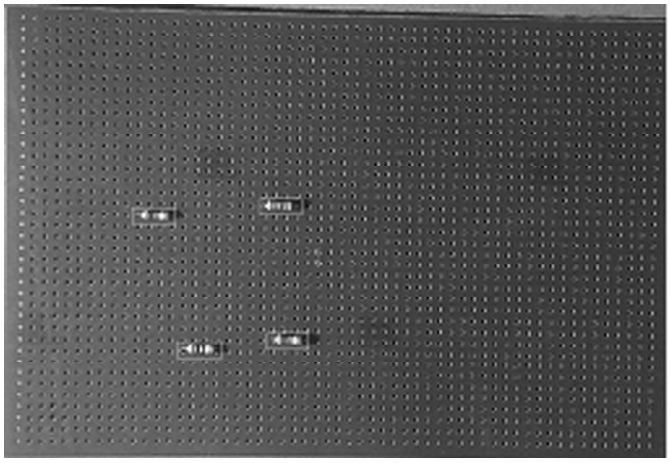


Figure 1: Detected Resistors

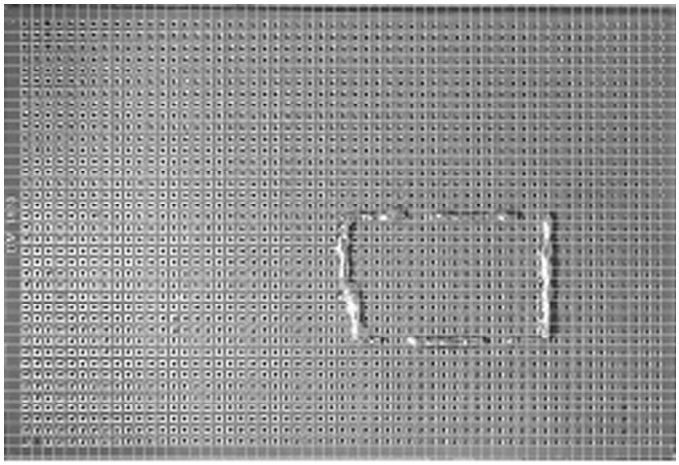


Figure 2: Reference Matrix.

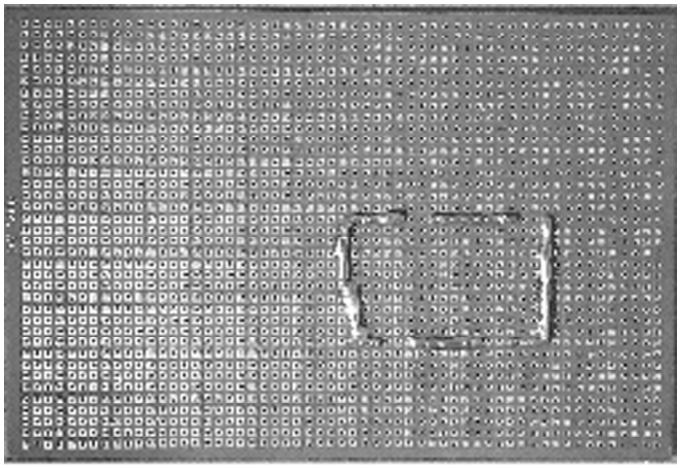


Figure 3: Detected non-soldered points.

By updating this matrix the circuit is being converted into digital form which can be used to manipulate the connections between the reference matrix of the front and back image.

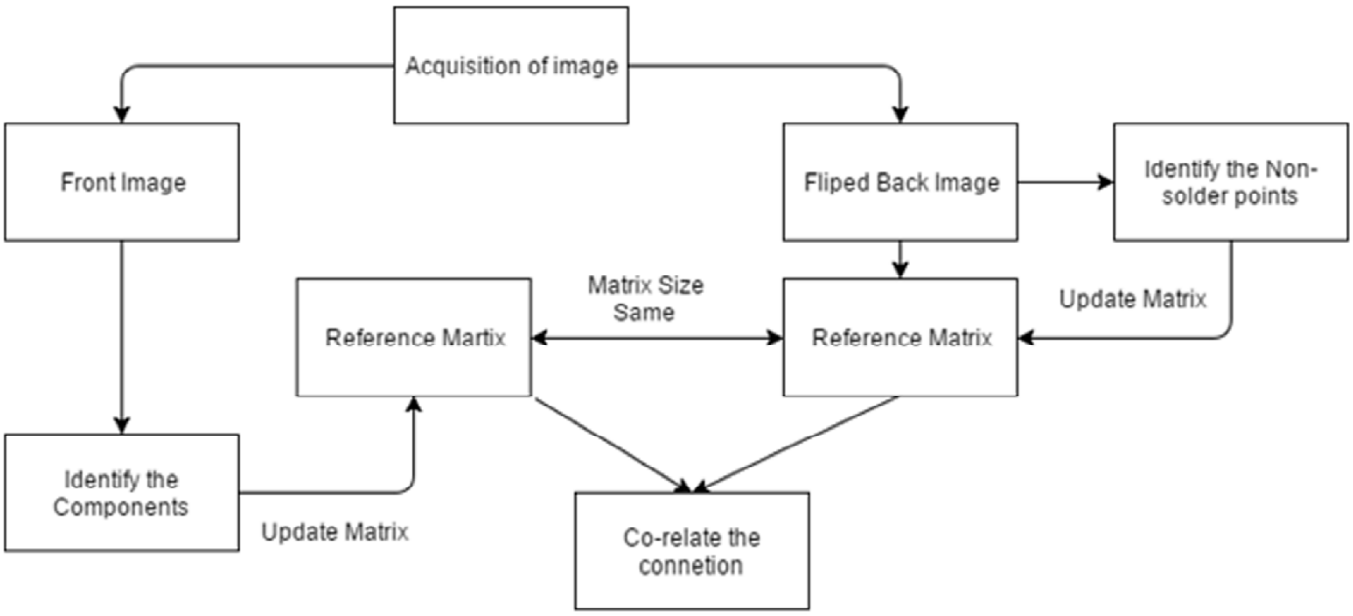
6. ESTABLISHING CONNECTIONS

As the matrix are being updated based of the non-soldered point there is possibility of errors which can be avoided. If the matrix has only one location as 1 and surrounded by 0's then it's not a connection which can be avoided.

For a connection to be series or parallel it's necessary to know from there the power is being supplied only then the connection will be proper. The initial point where the matrix will be fed in. From there the iterations starts to find the matrix values 1 using backtracking method (up, down, left, right direction) if found the co-ordinates are fed into the queue and this keeps on going until one of the co-ordinates of the components are detected[9].

When one component is detected and if the loops end then the circuit is said to be in series with one another and if the iterations lead to more than one component then the components are said to be in parallel with one another.

Block Diagram of the proposed method



6.1. Discussion of Results

The Fig 3 shows the identified electrical component after passing through the cascade training with the parameters of Minimum hit rate as 0.999 and Maximum False Alarm Rate as 0.5

Fig 4 represents the reference matrix of the back image where each co-ordinate represents the hole in the perfboard.

Fig5 is the result of detection of non-solder points in the perfboard using Hough Circle Transform.

The future scope of this is to simulate the circuit in a proprietor software after identifying the connection with in the circuit. Identifying the values of the component also helps in simulating the circuits output.

7. CONCLUSION

Even though the process designing a circuit in PCB is made simpler using different software's the reverse processing of extracting a circuit from an existing printed circuit board is not common. From the results

that was obtained there is significant improvement in establishing the connection between the component and the solders connections.

This proposed novel method helps in increasing the efficiency of analysing the circuit and establishing connections between the components and the identified solder.

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