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PCB LAYOUT DETECTION USING EUCLEDIAN DISTANCE ALGORITHM

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ABSTRACT

In the image identification process, the determination of geometric coordinate transformations must be in line with the two images. To identify the tested image, the size of similarity is defined by the alignment quality of these two images, which measures the similarity between the tested and the fixed image. So that to detect PCB layout, it also be determined by matching the PCB image reference feature with the tested PCB image based on differences in the imaging conditions result. Ideally, a good similarity measurement has almost a zero deferent value and a larger value for different images. Therefore, the Eucledian distance algorithm is proposed in this paper to detect similarity among PCBs layout with 15 training image and 30 tested images samples. Each training image has a varying reduction quality of image. From the simulation results can be concluded that this algorithm can be used in a detecting similarity of PCB layout.

KEY WORDS: Layout, Euclidean, simlarity

INTRODUCTION

Today, computer vision roles a very important mission in the field of engineering and its usefulness is widely used in research where extensive image knowledge is needed to find out how to process it. From a classic point of view, images are things that can be viewed by the eyes. However, researchers have agreed with various types of images and models of images in the true sense as a mathematical model represented in the form of a matrix. An image with a gray scale is a simple example where this model is a humble and widely used in several applications. The image processing model is defined as image manipulation to extract information or features and produce alternative representations. Features or information from the taken images are very important parts in computer vision applications. For example, to identify an obtained image has a different angle of view, and a different sensor used.

Image identification is the process to find the geometric coordinate transformations in line with difference of two images. The difference of comparison between the two images was introduced due to different image conditions. The tested image remains in accordance with the recommendation image. The alignment quality of these two images is specified by the similarity of the size, which measures the resemblance among fixed images and the defect (tested image). Ideally, a good similarity value approachs a zero value to identify the same image and a larger value to specify different images. Nowadays, the visual inspection industry has served and needed to increase the quality of manufacturing products. Advances in manufacturing product design such as printed circuit boards (PCBs) create new challenges in manufacturing and testing processes. Automatic inspection has great strength to truly automate inspection by human visual procedures and therefore, many researchers are attentive in this area and pay attention to give automated inspection systems. In the literature, there are various techniques for visual inspection, namely fuzzy rules based on neural network method, and image difference methods.

Based on the various techniques of visual inspection above, this paper will introduce the eucledian distance technique for detection image of the original PCB layout in measuring 150 x 100 pixels with any test PCB's that has some defects. This technique used to calculate the eigenvector value and Eucledian distance to compare with the original PCB layout. Chapter 2 will be discussed about the methodology used in this research. The next chapter discuss about the results and discussion of this research.

LITERATURE REVIEW

2.1 System Design Process

The data used in this experiment is the image data of several PCB layouts by a size of 100 x 150 pixels with 24 bit jpg. Data entered in the system will be analyzed to detect the existing PCB layout image.

There are several stages to recognize the PCB process. The first is the PCB collection of training image stage will be processed into a single matrix as input to obtain the eigenface value. After completing calculation, the new PCB image will be recognized by looking for the eigenvalue in the test image to get

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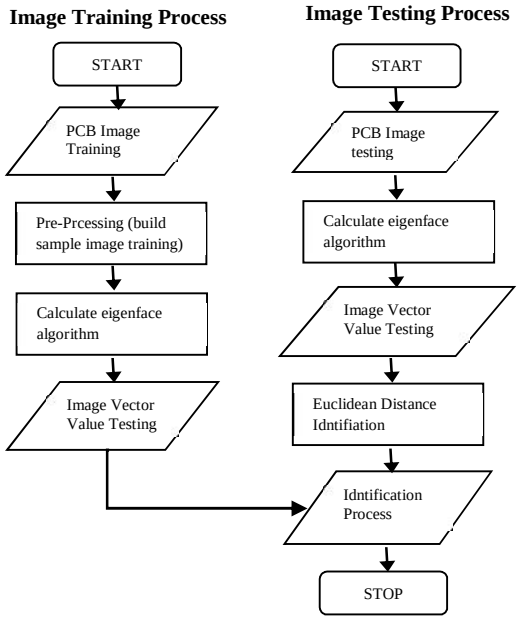
eigenface value. After knowing the eigenface value of every image and tested image data, it can be continued with the next step by comparing the eigenvalues in the training image with eigenvalues in the tested image using the euclidean distance calculation for the identification process. All sample images is used as inputs and the used images for the introduction stage must have dimensions with the same size. The following flow chart of the PCB recognition uses the main component analysis method to calculate the euclidean distance.



To design the PCB recognition system using the eigenface method have several stages including:

1. Pre-processing,
2. Feature extraction using the Eigenface algorithm,
3. The introduction process using the euclidean distance calculation.

1. Pre-processing

Pre-processing is the initial process after collecting image data. It purposes to prepare training images that are processed by the system so that the contained information is feasible to be processed in the next process. In this process it starts by converting RGB 3 layer matrix image into one grayscle matrix layer (gray scale). Gray-scale images are also easier to process because they contain fewer 8bit values than 24bit colors RGB images.

After getting the grayscale image, the process is continued by converting 2D image collection into 1D vector matrix. This reduction dimension is to facilitate the average search. For example in the training image database, an image by a size of 150 x 100 pixels then the results of the 1D vector are as follows:

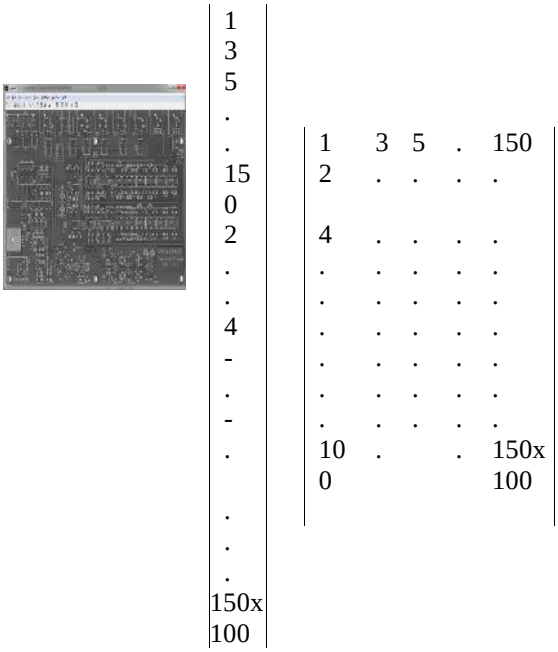


Figure 2.1. 2D Image conversion into 1D

In Figure 2.1, the conversion from 2D image to 1D dimensions is finished on all training data images that have been converted to grayscale images. After trainings the images are converted to 1D images, and then the next is to combine them into a T [] matrix.

2. Eigen face algorithm

The basic principle of identification of PCB images is to quote a unique information on the PCB image in the training database and then the information is compared to the get features that have been obtained on the image to be tested. Each PCB layout is act for a linear eigenface combination. There are five step to acquire eigenface value:

1. The calculation of the average image of matrix ($\bar{x}$) using equation:

$$\bar{x} = \frac{1}{n}\sum_{i-1}^{n} x_i \quad \text{..... (2.1)}$$

$$\bar{x} = \frac{\text{the number of each row}}{\text{the number of training images}}$$

2. Finding the difference (Φ) between training images (x) with an average value ($\bar{x}$).

$$\Phi = \Gamma_i - \bar{x} \quad \text{..... (2.2)}$$

Φ value is needed to get data centered on the training image and to search the covariance matrix that will be used as input to classify the distance function.

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3. Calculating the covariance matrix (C) by the m x m dimensions, namely the pixel number x the pixel number as follows:

$$C = \frac{1}{M}\sum_{n-1}^{M} \Phi_n \Phi_n^T \quad \text{..... (2.3)}$$
$$L = A^T AL = \Phi_m^T \Phi_n$$

AT is the transpose matrix of matrix A. The result of the covariance matrix is inputted into the matlab program to find eigenvalues and eigenvectors values.

4. Calculating the eigenvalue (λ) and eigenvector (v) of the covariance matrix (C)

$$C\ x\ v_i = \lambda_i\ x\ v_i \quad \text{..... (2.4)}$$

Eigenvalue is a characteristic of a square matrix, while an eigenvector is taken in referencing an eigenvalue greater than zero. Eigenvector is generated by replacing the eigenvalue value (λ) into the equation (λI - L) v = 0.

5. After obtained eigenvector (v), the eigenface (μ) can be searched using the following formula:

$$\mu_i = \sum_{k=1}^{M} v_{i,}\ \Phi_k \quad \text{..... (2.5)}$$

3. Euclidean Distance

The difference from the average value of the line in the training image data to estimate the feature vector from the image can be tested by Projected_test_image = Eigenface x Difference.

The function is to determine the similarity of two weight vectors between images in training data and tested images in Euclidean distance as below.

Euc_dist = (Projected_test_image – Projected_image)^2 ..... (2.6)

DISCUSSION

The initial process of identifying PCB images is collecting PCB images. In this case the researcher took several samples of PCB images through the internet which were then processed for equal dimensions. The PCB image recognition system program is tested by detecting circuit layouts. This study is limited in the referencing of PCB images in training and tested images data with lines that are blurred, unclear and very clear. The results shows that the shape of PCB layout still be identified accurately.

1. The first experiment

The tested image used the PCB image with the blurred line. Table 3.1 describes the results of the minimum euclidean distance value in PCB-3 known as the original PCB.

Table 3.1 Results of test euclidean distance with a blurred lines.

PCB Image Tested with blurred lines

The image trained		Euclidean Distance Results
PCB-1		4.4589e+16
PCB-2		3.481e+16
PCB-3		**1.300e+15**
PCB-4		1.988e+16
PCB-5		3.0297e+16
TEST RESULT	 Tested Image	 known as PCB-3

2. The second Experiment

The tested PCB image is an image with a rather blur layout. The tested image used is a PCB image with a rather blurred trajectory. The results from table 3.2 show that the tested PCB images with a blurred path capable is recognized as identified from the original PCB board image has the minimum euclidean distance value (PCB-1). The eucliedian distance results are obtained from the image of training data and tested image.

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PCB image that is tested with a blurred layout

Table 3.2 Results of test euclidean distance with a blurred layout.

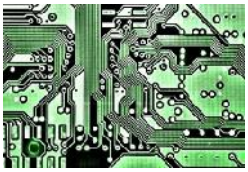
The image trained	Euclidean Distance Results	
PCB-1	**5.631e+15**	
PCB-2	9.282e+16	
PCB-3	7.258e+16	
PCB -4	5.5864e+16	
PCB -5	6.961e+16	
TEST RESULT	 Tested Image	 known as PCB-1

3. The third experiment

The tested PCB image was used in this experiment is a PCB image with a very clear layout. There are several failures obtained in the test which the tested image is not able to recognize the image in the training data due to several factors such as the quality of image training data or tested image, the algorithm used, pre-processing results, retrieval of features with less than optimal results by eigenface algorithm, etc.

The image to be tested has brighter illumination image than the image of training data. The simulation results show that the image data has the closest distance value to the original image. Therefore, the training image with the nearest euclidean distance is recognized as the image from the original PCB.

Table 4.3 Results of test euclieand distance with a bright layout.



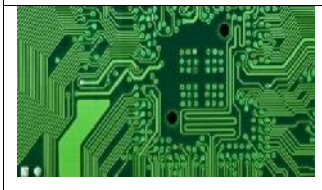
PCB image tested with bright layout

The Image trained	Euclidean Distance Results	
PCB-1	9.282e+16	
PCB-2	7.258e+16	
PCB-3	5.5864e+16	
PCB -4	**5.631e+15**	
PCB -5	6.961e+16	
TEST RESULT	 Tested Image	 known as PCB-4

4. The fourth experiment

In the training image with fiveteen PCB image samples were used, but thirty test images used to test images where each training image experienced a varied image quality decline. These examples of data acquisition results with 150 x 100 pixels are tabled in table 3.4. From this table, we can see that the fiveth image trained can recognie with different layour modification such as blurr, crips in PCB layout as below :

Table 3.4 Examples of PCB training images and PCB test images

The Trained Image	The Recognized Tested Image
	

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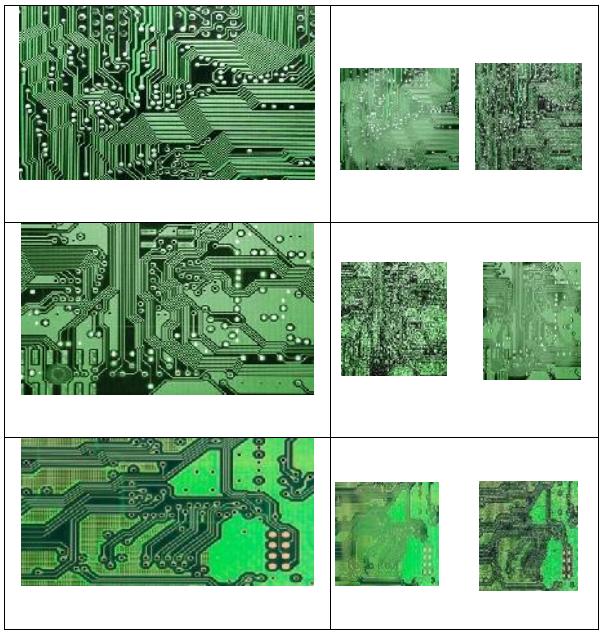

CONCLUSION

1. The smaller value of euclidean distance between the training image data and the tested image has the most similarity.
2. In the four experiments of the tested PCB image in a blurred condition, crisp, unclear, and very clear lines can be recognized with Eclidean distance.
3. The results shows that the PCB layout shape still be identified accurately using Eclidean distance.

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