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Study on the Flaw Recognition Algorithm Based on Neural Network

[1]Zhang Daode, [1]Xue Yangliu and [1]Hu Xinyu
School of Mechanical Engineering, Hubei University of Technology, Wuhan, 430068, Hubei, China

Abstract: Based on cognition and research for vision measurement method on chips' defects, a new type of chip defects detection algorithm is proposed. In view of defect characteristic and examination request of chips' surface, the first is pre-processed on the images by CMOS camera. This process includes gradation?median blur?iterative segmentation and contours extraction on images, which will get the chips' contours including targets and backgrounds with stark contrast. On this basis, the chips' online defect detection and classification algorithm including defects extraction and classification is researched. The defects extractions carried on the invariant and geometric positioning features of invariant moments to chips' image correction and then use frame-difference method to extract defects. The defects classification is that a hybrid algorithm based on RBF Neural Network algorithm is applied to achieve the online detection for chips by real-time, fault-tolerant characteristics of neural networks. Above all, it satisfies the requirements of online detection.

Key words: Vision measurement, frame-difference, neural network, defects classification

INTRODUCTION

In the process of chip manufacturing, carrying on the sorting flaw detection and recognition is the premise of the right packaging. Surface scratch and deformation is one of the important causes to lead to the error of the patch (Liu, 2007). Common method is difficult to meet the requirements of the SMT chip high speed and high precision detection identification, therefore, computer vision technology, as a kind of non-contact measuring technology has been applied and will become the one of the main means of industrial detection (Ye and Zhu, 1999). The defect recognition of patch chip and classification problem is one of the important problems that can not be ignored. Therefore, we use pattern recognition to solve this problem. In the field of defect recognition, due to its highly complex system model, there is a strong nonlinear relation between samples, so common way is not classified easily. And, as the rapid development of the Computer computing ability , storage capacity and Internet technology, the amount of data of the problems dealed with by computer pattern recognition system is becoming more and more large and pattern samples are also more and more complex and there is higher and higher demand to the classifier (Mu, 2006). Therefore, how to get scientific, accurate and reasonable pattern recognition effect and build the pattern recognition system model has become a significant research direction.

CHIP OWERVIEW OF FLAW CLASSIFICATION ALGORITHM

Chip flaw classification algorithm is mainly to solve the assembly line chip blemish automatic identification problem. Before classifying chip defects, of course, we need to put the chip defects out and get the defects of several common parameters as criteria for the classification of defects. In this paper, the chip defects classification algorithm mainly includes the following sections:

- The Chip defect image preprocessing algorithm in the detection system. Including the image filtering de-noising, the threshold segmentation and edge detection and so on, a series of preprocessing algorithms. Finally getting the clear outline of chip images
- The Chip defect image feature extraction algorithm. Mainly adopting the method of image registration to realize feature extraction and image just contains defective parts after registration and obtaining several common parameters of defective parts
- The Chip flaw classification algorithm. This is the core of this article, a optimization clustering algorithm based on the clustering rationality function F is mainly proposed, based on the algorithm to optimize the process of clustering of input samples and then

Corresponding Author: Zhang Daode, School of Mechanical Engineering, Hubei University of Technology, Wuhan, 430068, Hubei, China

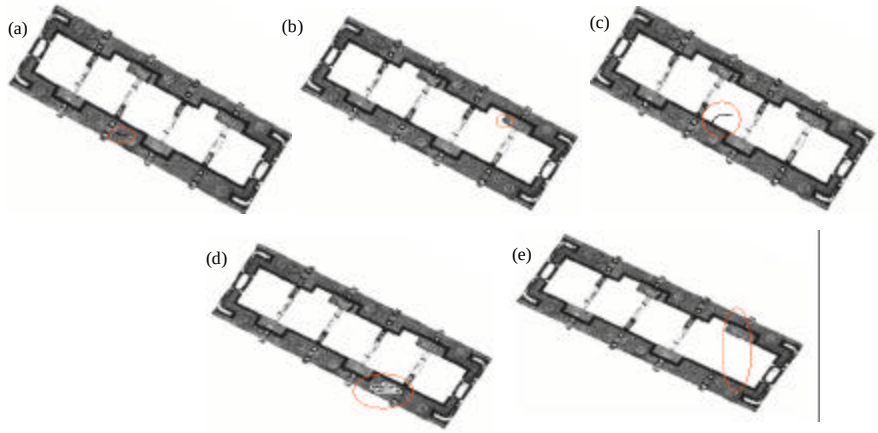

Fig-1(a-e): Image to be measured, (a) Scratch, (b) Burr, (c) Broken Filament, (d) White spot and (e) Packing

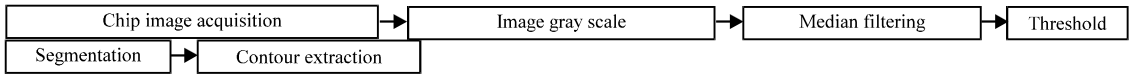

Fig. 2: Chip image pretreatment process

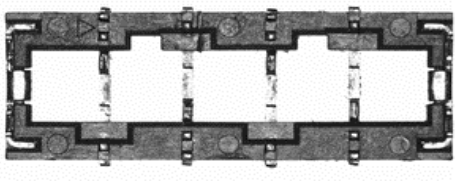

Fig. 3: Template image

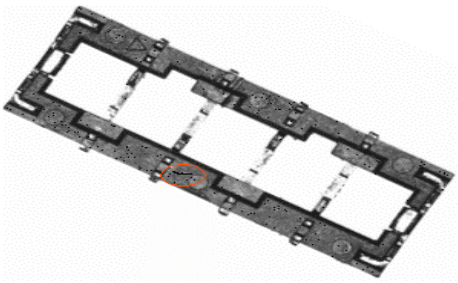

Fig. 4: Image to be measured

clustering on the number of groups as a RBF neural network hidden layer unit number, calculating the RBF parameters of the initial value at the same time, to make the network classification is more correct, by adjusting the threshold function F, driving the amount of gradient method is used to train network parameters, in order to achieve classification effect. Common chip defects are shown in Fig. 1:

CHIP DEFECT CLASSIFICATION ALGORITHM

Chip image preprocessing: After the image acquisition of the chip is completed, the pretreatment about obtaining chip image will be conducted. In this study, the method of the pretreatment can be divided into the following steps Fig. 2:

Because of several common defects and scratches are handled equally, so scratch defects is the main research object in this study. After pretreatment, the results are as shown in Fig. 3, 4 and 5.

The extraction of chip defects: Chip defects mainly through the extraction of image registration. The process mainly has the following steps:

Invariant moments correction. On rotating shift invariance of moment invariants and the research on the basis of geometric positioning properties, by geometric moment to calculate the template image and the image centroid coordinates $\bar{x}$ and $\bar{y}$ nder test and calculate the relative coordinates Δx and Δy, using the geometric feature of invariant moments calculated spindle Angle θ, So you get the template image and the relative position of the image under test and then rotate and translation parameters above, the location of the two images are basically identical.

Registration frame differential method (Yang, 2005). During the registration process of chip image frame difference method, we adopted the dynamic reference image: With chip images under test before a picture of a

Table 1: Defective sample

Serial no.	1	2	3	4	5
Defect types	Burr	Broken filament	White spot	Scratch	Packing
Area	1.000000	6.000000	25.000000	4.000000	76.000000
Length	18.142136	35.342346	57.689435	24.564331	276.985420
Sizes	7	21	47	16	105

Among them, the area and the length of the unit are all pixels

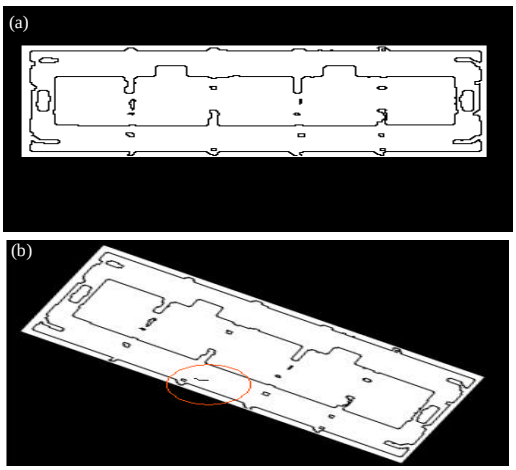

Fig-5 After preprocessing of images

Fig-6 Chip after image frame differential method

zero defect image as a standard image difference operation with chip image to be detected, this method had a correct image as a difference after processing the benchmark image, so avoid caused by acquisition synchronization performance is not good the image position of the cumulative error (Jiang, 2009). The results of frame differential method as shown in the Fig. 6.

Based on several common chip defect image registration and threshold segmentation, can draw the following rendering as shown in Fig. 7.

Several common flaws in this way, the chip is to find out, for the purposes of classification, we calculate the defects of several kind of geometric parameters, the results shown in the Table 1:

Chip defects classification: Neural network as an important subject in recent computer that is widely used in the identification of defects classification, in order to achieve the neural network's characteristics of real-time, fault tolerance and learning. Through the study of some neural network method in this chapter, on the basis of the traditional algorithm of RBF network, with a kind of hybrid algorithm is proposed in the RBF neural network algorithm, simulated experiment on chip defect samples and the traditional algorithm of RBF network, comparing the performance parameters of such chips can be seen that the algorithm in the superiority of defect classification.

Principle of hybrid algorithm of RBF network: RBF is a kind of three-layer feed forward network, (Fig. 8) the number of input layer and output layer unit by specific problems, hidden layer unit number can be changed, function is RBF hidden layer unit, it is a local distribution center of relative attenuation of radial symmetric nonnegative nonlinear function. In this study, the geometrical characteristics of the input for the defect parameters, output for the types of defects. Control is

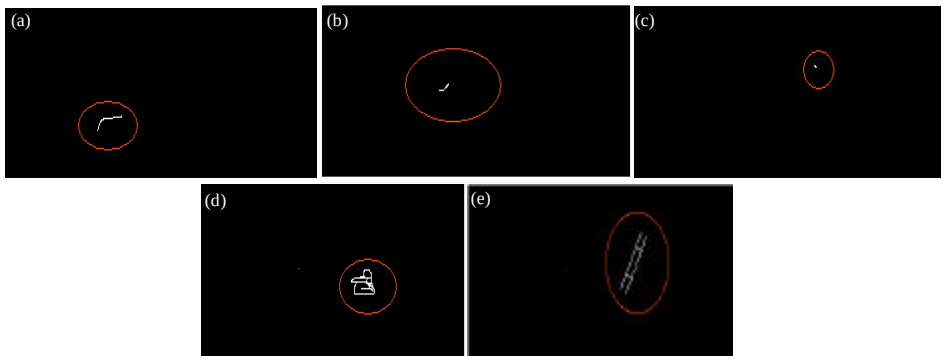

Fig. 7(a-e): After threshold segmentation of image, (a) Scratch, (b) Broken filament, (c) Burr, (d) White spot and (e) Packing

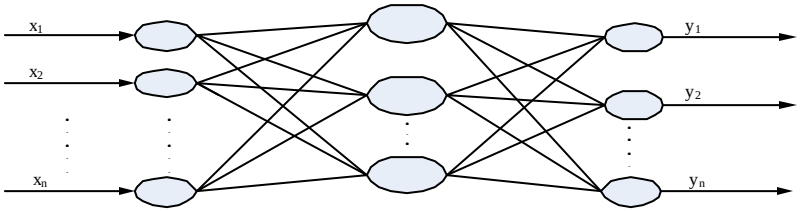

Fig. 8: Structure diagram of RBF neural network

mainly based on the clustering rationality function F a optimization clustering algorithm is proposed, based on the algorithm to optimize the process of clustering of input samples and then clustering on the number of groups as a RBF neural network hidden layer unit number, calculate the RBF parameters of the initial value at the same time, to make the network classification is more correct, by adjusting the threshold function F, drive the amount of gradient method is used to train network parameters, in order to achieve classification effect. Based on RBF neural network hidden layer to output layer is linear mapping, the characteristics of orthogonal least squares training of network weights. Thus to achieve the optimal clustering algorithm (Poggio and Girosi, 1990), an algorithm of gradient method.

The structure and principle of RBF network:

RBF network is composed of three layers, the output of the network are as follows:

$$y_k(x) = \sum_{j=1}^{J} w_{kj} f_j(x_j - c_j) k=1, 2, 3..... \quad (1)$$

In the formula J is the number of hidden neurons inlayer RBF, w_{kj} is the hidden layer J and output K weights between neurons, c_j is the center of the J RBF vector, x_j is the input vectors.

The output of the network structure of RBF:

The kernel function of RBF network ϕ_j (x_j-c_j) has many kinds of forms, Gauss type function:

$$f_j(x_j - c_j) = \exp[-\frac{(x_j - c_j)^T (x_j - c_j)}{2s_j^2}] \quad (2)$$

In the formula, σ_j is a constant.

Optimization clustering algorithm: In order to seek the input vector to collect samples of reasonable clustering results, which is based on the identification of the RBF neural network hidden layer nodes m, cluster rationality functions commonly used control:

$$F = \frac{1}{N}\sum_{j=1}^{m} \| x_j - c_j \|^2 \Big/ \frac{1}{m-1}\sum_{j=h} \| c_j - c_k \|^2 \quad (3)$$

After determing the number of hidden layer nodes of RBF network m and the center c_j, on the rationality of available judgment clustering. The significance of math F: if the function F by clustering the same class of input samples and closer, different clustering center is farther, the better clustering results of rationality (Xi and Zhao, 1983).

In this study, the basic thought of optimal clustering algorithm that stated as follows: reference optimization algorithm in the neighboring optimal, optimizing method with one-dimensional, preferably radius, the function of F minimum. Through clustering to determine class number of clustering algorithm m and each class center c_j. The main algorithm is optimal algorithm of radius, first calculate the optimal radius r_{op} of interval, after the method of interpolation for r_{op}.

Assuming k_{ij} corresponding to the I class in the j member of the sample number, n (i) the number of stored I samples; Following the under symbol array:

f (k) 1, If x is classified
0, If x is not classified

fl (i) 1, If I is classified
0, If I is not classified

Clustering algorithm is used for the control class of rational function F. The main process is as follows.

Radius of preferred value obtained by the radius of the optimization algorithm and then the number of samples $S_m = 0$, f (k) = 0, fl (i) = 0.

Order the number of hinder layer notes m = 1, m0 = m, c1 = x1, f (1) = 1, k (1,1) = 1, n (1) = 1, $S_m = S_m + 1$.

Form i = 1 to m0, if fl (I) = 0 and then suppose M is a positive real number, order The Euclidean distance $d = \|x_i - c_i\|$, if $d<M$, the optimal sampling number $k_{op} = k$, $i_{op} = i$

Order m0 = m, $S_m>N$, Calculate, i = 1, 2, 3 ..... N

Reasonable calculation functions of F value.

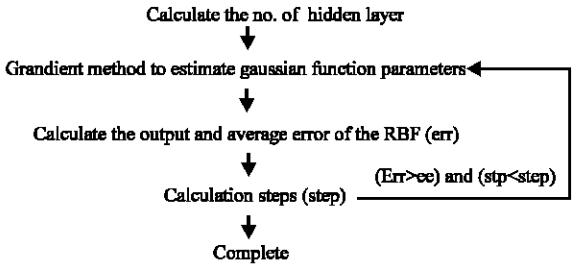

Fig. 9: Hybrid algorithm process

Gradient algorithm: Assuming that all the defect sample disconnected, then covariance matrix, standard deviation matrix into a diagonal matrix. Set up n_d for the total sample, the sample of, j = 1, 2, 3.... A gauss function mean vectors, covariance matrix, deviation matrix respectively m_i, R_i, r_i,i=1,2,3….n_h. The n_h is the number of neurons in hidden layer.

Gradient algorithm steps:

Step 1: Initialization iteration step number T and gives the maximum number of iterations of step

Step 2: J from 0 to N, the initialization of gradient vector: grad 1 [i] = 0, grad 2 [i] = 0, I = 0, 1, 2 ... (Ma and Yang, 2001)

Step 3: The output error calculation of RBF neural network

Step 4: Calculation of grad1 [i] and grad2 [i], in the calculation of the gradient vector, adding inertia

Step 5: Iterative calculation of mean and standard deviation values

Hybrid algorithm: The unit number of RBF neural network input layer and output layer about Hybrid algorithm obtained by the specific calculation of the input samples. The number of units in the hidden layer obtained by optimal clustering algorithm, accuracy for ee. Procedural steps are as follows Fig. 9:

Data analysis about identification experiment of chip flaw: To simulate the result via using traditional RBF network and the one with a hybrid algorithm, extract geometric parameters of 1-5 class defects in the sample library (Table 3), simulation by two kinds of algorithm, the input layer unit number is 15, output layer unit number is 5, precision is 0.01 and the largest number of iterations is 10000. Results are shown in Table 2 and 3.

It can be seen from the Table 2, under the same precision requirements, compared with traditional RBF network, the iteration steps, operation time and average error of Hybrid Algorithm for RBF network are reduced. Experiments show that the average error within ±0.2, it means that RBF network with hybrid algorithm has good generalization ability.

Table 2: Comparison of two kinds of RBF network

	Precision	Iteration steps	Run time	Average error
Traditional RBF network	0.01	6779	276s	0.0763
Hybrid algorithm of RBF network	0.01	4208	109s	0.0064

Table 3: Classification results

1	2	3	4	5
Scratch	Broken filament	Burr	White spot	Neglected loading

CONCLUSION

This topic is aimed at the identify classification problem about patch chip defects on the assembly line, puts forward a relatively new testing method in allusion to the existing problems about identification chip flaw detection in the actual production. This has a series of advantages such as high detection accuracy compared with manual visual method low failure rate and so on.

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