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Application of Fast Deviation Correction Algorithm Based on Shape Matching Algorithm in Component Placement

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Abstract

For contradiction PC template matching between accuracy and speed, combined with the advantages of FPGA high speed parallel computing. This paper presents a FPGA-based rapid correction shape matching algorithm. Mainly in the FPGA, using shape matching and least squares method to calculate the angular deviation chip components. Use single instruction stream algorithm acceleration. Experimental results show that compared with traditional PC template matching algorithms, this algorithm to further improve the correction accuracy and greatly reducing correction time. And SMT machine vision correction can be obtained in a stable and efficient use.

Key words: Surface mount system; Correcting; Shape matching; Edge detection; Least squares

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INTRODUCTION

With the development of market economy, the quantity of trademark increases progressively year by year. The tradition trademark image retrieval based on classified or text labeling has many problems, including the very load of manual illustration work, subjectivity, inaccuracy, etc. Content-based image retrieval (CBIR) technology can overcome these problems, so it obtained the very widespread application in the trademark retrieval domain.

At present, high-grade placement machine has been extensive use of fast, accurate and easy computer processing of machine vision systems, etc. Its role is to detect the angle deviation SMD components. Objective mount components ensure high accuracy, with the element placement of non-contact and non-destructive characteristics. As semiconductor process technology development, electronic component density and complexity increases, as well as shrinking component size and spacing of the existing correction methods cannot meet the accuracy requirements of chip components.

Correction methods currently used pattern matching, mechanical Rectification. Pattern matching method, because of its large amount of calculation, the majority of the PC control, the calculation speed is slow; it cannot meet the demands of modern production. Mechanical correction method, because it is relying on mechanical action, so speed is limited. At the same time, the role of components against mechanical force easily damaged, especially the pin element is very vulnerable and difficult to maintain the placement quality. This method is speed, accuracy and quality cannot meet the requirements of modern production (Yu, 2010). To solve the above problem, a shape-based matching FPGA rapid correction algorithm to improve placement accuracy and processing speed, has great significance for research-grade placement machine. This paper presents a FPGA-based rapid correction shape matching algorithm, chip component placement angle to match the shape fast correction will be studied.

1. SHAPE-BASED MATCHING PROFILE

1.1 Shape Matching the Basic Concepts

In the visual field, the shape and image are closely linked. Shape information contained far more than the amount of information contained in the texture and color, is characterized by a higher level of image. The accuracy of matching shape by shape extraction quality impact, good shape description can simplify complex shape matching, more efficient. Poor shape descriptors are often not satisfied with the results. So shape description has a crucial role in the process of matching shape.

Describe the general shape into shape and contour shape description method described area-based approach based on (Xian, 2006). Based on the outline of the shape of the contour information description method is the need to extract shape. Describe a method based on the shape of the closed area is through internal curves describe certain characteristics. Since the chip component placement is based on the description of the characteristics of the profile, so the study, which is based on the outline of the shape matching the shape description method.

1.2 Shape Feature Description Method

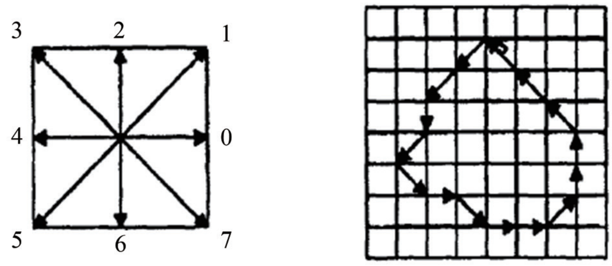
Shape description is one of the essential characteristics of objects, shape searching can improve the accuracy and efficiency of the searching. In general, the expression and description of shape features can be divided into two categories. These two categories are shape description based on external parameters (boundary) and shape description based on internal parameters (area).

1.2.1 External Parameter Description Method Based on Shape Boundary

The external parameter way of shape feature description is that shape parameter are extracted by the analysis of the peripheral contour of the target. The shape feature based on the external parameters can be obtained according to the global characteristics of the target contour (such as the length of the boundary). It also can be obtained according to their local characteristics (such as curvature).

1.2.2 Boundary Description Based on Chain Code

Chain code is an encoding expression of the boundary. It expresses the boundary of a target by straight line segments that has specific length and direction. For the pixels in the image, it has eight directions. Each direction is represented by a code. The eight directions are 0, 1, 2, 3, 4, 5, 6, 7, respectively. They are called directional codes. Assuming a starting point, the border region according to the above encoding is recorded, It can be formed as follows: *a*1, *a*2... *an*, the values of *a*1, *a*2... *an* are 0 to 7. This sequence is called chain code direction chain. From the Figure 1(a), it can be known that even chain code segment is vertical or horizontal direction code. And odd chain code segment is diagonal line segment. An area is shown in Figure 1(b), Assume that s is the starting point, it is rotated in the counterclockwise direction. The boundary chain code should be 556570700122333. The set of features of all regions can be obtained by chain code.



(a) Directional code (b) Boundary chain code

Figure 1
Example of Boundary Chain Code

(a) Regional circumference

Assuming that the boundary of the chain code is *a*1, *a*2... *an*, the length of each chain code segment is *L*, the perimeter of the area can be expressed by the Formula (1).

$$p=\sum_{i=1}^{n} l_i = n_{e+\sqrt{2}}(n-n_e) \quad (1)$$

n_e is a number of even chain code segments, n is the total number of chain code segments in the chain code sequence

(b) Regional diameter

The area diameter is the distance between the farthest points on the boundary. And that is the length of the straight line between the two points. Sometimes this line is also known as the boundary of the spindle or the long axis. (The boundary short axis, which is the between the two nodes, perpendicular to the long axis and the longest). The diameter *Dia* (*B*) of boundary *B* can be calculated by Formula (2).

$$Dia(B)=\max_{i,j}\{D(b_i,b_j)\}, b_i, b_j \in B. \quad (2)$$

In Formula (2) *D* (.) is any kind of distance measure.

(c) Curvature

Curvature is the slope of the change rate, the curvature at a point on a curve is defined as the change of the tangent of the point along the curve.

1.2.3 Boundary Description Based on Approximate Polygon

Because the influence of noise, there are many small irregular places at the boundary of a digital image, this has a great influence on the shape measurement and the description of the image. In order to reduce these interferences, linear fitting method is used for data processing, and then the polygon is close to its boundary, the boundary of the test image is approximated by a polygon. A few of Lines represent its boundaries, and maintain the basic shape of the original boundary, so that it can be regarded as a polygon. Finally, the shape is described by calculating the parameters of the polygon. There are three kinds of commonly used methods of polygon approximation, the one is minimum perimeter polygon method based on shrinkage, the two is the least mean square error line segment approximation method based on aggregation, the three is the minimal error line segment approximation method based on division.

After the polygon approximation to the graph, a similar to the original shape of polygon will be obtained. The error value can be changed by setting the threshold value. From the theoretical analysis, it can be infinitely close to the original graphics, then the shape of the object is approximate measured by calculating the parameters of the polygon. Here are some common calculation parameters.

(a) The number of a polygon vertices

If there are many vertices of a polygon, it shows that the shape of the polygon is more complex. If the number of vertices of the polygon is different, they can be judged by the difference in their shapes.

(b) Concave points

Concave point number of polygon reflects the degree of concave convex polygon, it is an important feature of the description of a polygon. The concave points correspond to angles, its degree is greater than 180 degrees. If there are concave points, the corresponding polygon is concave polygon. If there is no concave point, the corresponding polygon is convex polygon. Usually concave point ratio $K=Dn/D_o$ represents the concave convex degree of polygon. D_o is concave points of polygons, D_n is the number of vertices of the polygon.

(c) The average value of interior angle

The average value of interior angle is an overall description of the angles of the polygon. It can be calculated by the average number of polygon edges. According to this reason, distinguish the triangle quadrilateral, pentagon etc.. According to this, the triangle quadrilateral and pentagon are distinguished. The average value of interior angle is greater, the shape of an object is more complex. If there is a *n* vertex of the polygon, The formula of average of interior angle is shown in Formula (3).

$$a_{avg} = (n - 2) \times 180 / n \,, \tag{3}$$

n is the number of vertices of the polygon.

(d) The standard deviation of interior angle

The standard deviation of polygon interior angle is a concept describing angle distribution uniformity. The shape of a polygon is more rules, the standard deviation of interior angle is smaller, vice versa. For example, the standard deviation of rectangular interior angle is zero, the interior angle standard deviation of quadrilateral with irregular shape is greater than zero. Therefore, according to the standard deviation of interior angles, irregular polygon and polygon with irregular shape are distinguished. The calculation formula of interior angles standard deviation is as shown in Formula (4):

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(a_i - a_{avg})^2} \,, \tag{4}$$

a_i is the value of the polygon interior angle, a_{avg} is the average value of the regular polygon interior angle.

(e) Interior angle histogram

Interior angle histogram of polygon is divided equally or divided into non isometric *K* interval in the 0-360 range. Then the probability of the polygon inner angle in each interval is calculated. In order to describe the angular distribution of the polygon. Separation point selection in the interval determines the description of Interior angle distribution characteristic.

1.2.4 Boundary Description Based on Internal and External Closed Object

If any two points of the graph are connected, and it is in the interior of the graph, such a graph is called as a convex shape. Minimal external convex is the convex shape that contains the smallest area of the graph. The maximum inscribed convex is the convex shape that contains the largest area of the graph. After a polygon approximation algorithm is applied to graphics. The vertex set of the approximation polygon is obtained, then search for vertex set, concave points are removed, the rest of the vertices is connect in the order. So that the smallest outer convex shaped graphics are obtained. Here are commonly used to describe the internal and external closed object.

(a) Convexity

The definition of convexity is $P= St/So$. In the formula, *So* is the area of the object's approximation polygon, *St* is the area of the object's maximum inscribed convex. The convexity of the convex is 1, the convexity of star Line is 0.

(b) Concavity

The definition of concavity is $c=1-So/Sr$, it is also the smallest area of external convex. In the formula, *So* is the polygon area of the object, *Sr* is the smallest external convex area of the object. The concavity of convex is 1, the concavity of star Line is 0.

(c) Convexity and concavity

The definition of concavity and convexity is $S= St/ Sr$, in the formula, *St* is the maximum inscribed convex object area, *Sr* is the area of the object's smallest outer convex. Convexity, concavity and convexity and concavity is an important concept of object shape, it reflect its punch.

1.2.5 Other Representative Boundary Description Method

There are many other boundary description methods, such as the boundary direction histogram.

(a) Boundary direction histogram

Firstly, Statistics on the edge direction are done, According to this; the shape of the object's histogram is obtained. To some extent, it reflects the shape information of the image. If there are more rules in the image, the edge direction histogram can have obvious periodicity; and if there is no rule in the image. The edge direction histogram will be random, the edge direction histogram to describe represented by Formula (9).

(b) The Fourier descriptors

Fourier transform is one of the description methods of transform domain. It is the basic thought that chooses the object boundary Fourier transforms as its shape description. By using Fourier transform Contour function transform from time domain to frequency domain. Features are extracted as shape index.

Assuming that in the *XY* plane there are a digital boundary which is composed of *N* points. From an arbitrary starting point ($x0$, $y0$), It is moved along the border in counterclockwise direction. A series of coordinate points ($x0$, $y0$), ($x1$, $y1$),… (xm, ym) can be gotten. If *X*, *Y* plane and complex plane *UV* coincide. The coordinates of each point can be represented in the plural form.

(c) Wavelet contour description method

The image contour is described by wavelet transform, first, we should select the appropriate basic wavelet, it is also called a mother wave; then the basic wavelet is moved in parallel and stretched. A series of wavelets are obtained, these wavelets are also called wavelet functions. This feature not only has the characteristics of Fourier description.

The contour feature of the image is represented by wavelet contour description method. Because the local changes of the image contour can only cause the local fluctuations of the wavelet descriptors. Because the local changes of the image contour can cause the local fluctuations of the wavelet descriptors. As a result, this method is more stable than Fourier description. But the selection of basic wavelet and truncation processing technique of coefficient often is difficult to practical application. So, it cannot be applied in practice.

1.2.6 Internal Parameter Description Method Based on Shape Region

The internal parameter method is the description of the shape of the object. Specific approach is the first to obtain a collection of all the pixels in the region of the object, and then it is described with this collection. These parameters are maybe geometric parameters, but also it is the density parameter. It can also be the coefficient energy spectrum of the region 2-D transform (such as Fourier transform and wavelet transform).

1.2.7 Conventional Area Descriptor

(a) Regional area

Regional area is a basic feature of the region. It is the feature parameter that represents the size of the region.

In the application of digital image processing technology. Regional area is defined as the number of pixels in the region.

(b) Regional centre of gravity

Regional centre of gravity is a global descriptor; it is the characteristic parameters of the object from the whole. Its coordinates can be calculated according to the points of all the regions.

In short, all of the above methods can describe the shape of the object, in the application of these shape description methods, according to the characteristics of these methods, the method is chosen easy to data processing. According to the characteristics of the image in this paper. The contour matching method based on the shape is chosen. In this paper, the related algorithms will be given based on this method.

1.3 The Contour Matching Algorithm Based on the Shape

In the shape of matching the field, the object is seen as a collection of discrete points. Shape information of the object can be represented by a discrete set of points or a subset of the object to obtain (Liu et al., 2011). Based on the outline of the shape matching process (Zhou, Liu, & Bai, 2012), as shown in Figure 1:

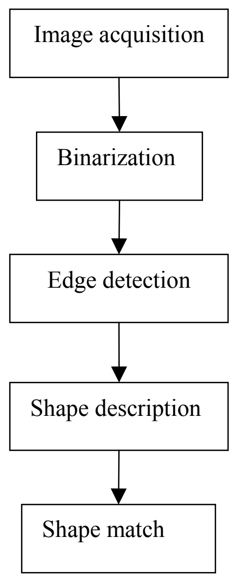


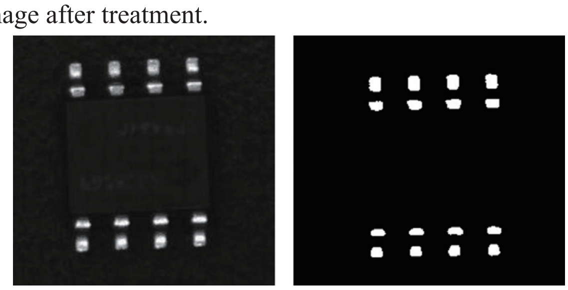
Figure 1
Shape Matching Flowchart

(a) Image acquisition

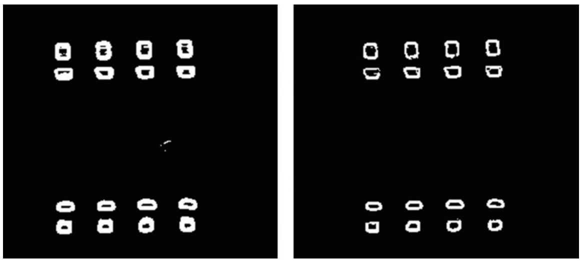
To match the shape of the image acquisition information.

(2=*b*) Binarization

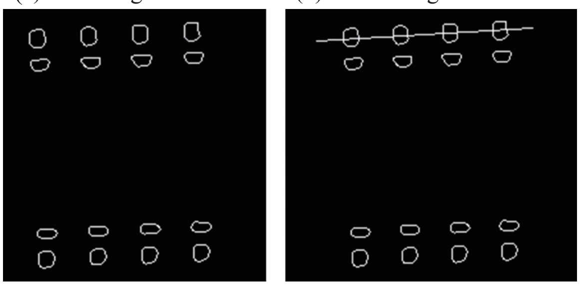
Image depth ranges of this study 0-255 levels. Binarization is 0-255 gray level image pixel values on the map by a fixed threshold method are zero or 255. Using FPGA in the comparator, if the pixel (x, y) at a value greater than or equal to the set threshold, the point is that the target area, otherwise the background value of zero. Binary image highlights the interest of the target area. Figure 2(a) is a gray-scale image. Figure 2(b) is a binary image after treatment.



(a) Grayscale (b) Binarization



(c) Sobel edge detection (d) Prewitt edge detection



(e) Roberts edge detection (f) The least squares fitting a straight line

Figure 2
Edge Detection Treatment Effect Comparison and Linear Fitting

(c) Edge detection

Edge pixels in the image refer to a value where a mutation, for the guidance element between the foot and the background pixel difference. There are currently used edge detection Sobel, Prewitt, Roberts and other methods. As shown in Figure 2(c), (d), (e) show three kinds of edge detection comparison chart. According to experiments, for detecting the sheet-like element, Roberts edge detection of the most clear and easy to follow the shape matching. Roberts operator using the image edge detection to identify the edges of the sheet-like element of each pin (Bai, 2010). Roberts operator in Figure 3(a) shown in:

$$\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} \quad \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \qquad\qquad \begin{bmatrix} z_1 & z_2 \\ z_3 & z_4 \end{bmatrix}$$

(a) Roberts Gradient operator (b) 2×2 pixel region

Figure 3
Gradient Operator and 2 × 2 Pixel Region

Wherein the extraction 2 × 2 pixel area is to use the FPGA shift ram two lines of image cache. At the end of each line of the cache shift ram two columns of pixels, the resulting 2 × 2 pixels. Suppose the symbol in Figure 3(b) represents 2 × 2 pixel dot image area, there Formula (5)

$$\begin{cases} G_x = -z_1 + z_4 \\ G_y = -z_2 + z_3 \\ \Delta f = \sqrt{G_x^2 + G_y^2} \end{cases} . \qquad (5)$$

Among them, G_x image in the x direction gradient operator, G_y image in the y-direction gradient operator, $\triangle f$ gradient modulus value. Calculate which root in the FPGA using altera company's intellectual property IP core.

(d) Shape description

Shape description is a need to match the target contour shape matching previously described, in order to be matched to the shape. As shown in Figure 2(e), each component pin circular contour similar, then for one pin, shown in Figure 4. Image resolution is 1,280× 1,024, which is 1,280 × 1,024 pixels, the depth of each pixel 0-255. Then the pin contour element is composed by a number of discrete points, which is a digital image. Shape description is a discrete point extracting characteristic shape. The elliptical boundary of the sheet-like element in which a pin outline in Figure 4, the characteristic shape of the contour of smaller circular dots to be extracted. In FPGA, using the memory descriptor matrix, the feature extraction of the desired shape represented in the matrix, which is described shape.

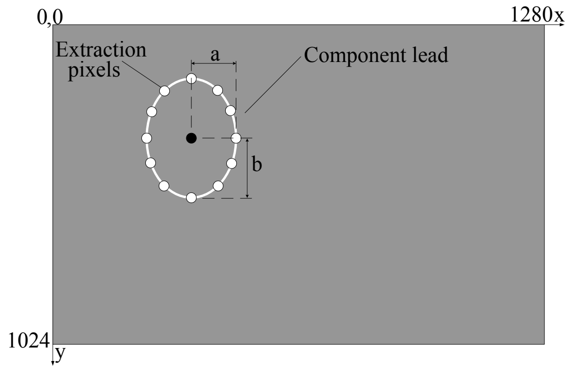


Figure 4
A Single Pin Shape Description Figure a Single Pin Shape Description

(e) Shape match

Described by the shape of the process is called to find the target shape matching. FPGA use 1.2 (d) described in the section shape of the image from the first line from left to right, top to bottom to traverse the entire image looking shape that matches the pin. Recording the coordinates of the corresponding component pins, represented by (x_1', y_1'), (x_2', y_2')…(x_n', y_n'). According to the direction of the match is from left to right, top to bottom, so in this case the coordinate value is the value of the target contour in Figure 4 under the rightmost. To get the coordinates of the center of the component lead, we want to be amended, modified after Formula (6)

$$\begin{cases} x_n = x_n^{'} - a \\ y_n = y_n^{'} - b \end{cases}, n = 1,2,3...n , \qquad (6)$$

a length of the target center and the right edge of the target Figure 4. b is the center of the target and the target lower side in Figure 4 the length of the edge. In order to facilitate the calculation, Formula (2), (n = 1, 2, 3 ... n) by (x_1, y_1), (x_2, y_2)…(x_n, y_n) to represent.

(f) Single instruction stream algorithm acceleration

Single Instruction stream algorithm means external trigger single instruction, FPGA internal trigger signal received after a full frame image acquisition. The process of collecting the data stream to match the shape of the image, and calculates the chip component angle deviation. Role is accelerating algorithms.

2. ANGLE CORRECTION ALGORITHM CHIP COMPONENTS

2.1 Deviation Generation

Paste titles draw components, depending on the camera move to the top position. Due to draw components, transportation and a series of actions, the elements will inevitably go awry, shown in Figure 5. Paste titles *X*, *Y* axis motor movement cannot meet the exact requirements of modern Mounted (Li & Qin, 2006). It is necessary to accurately calculate the angle element.

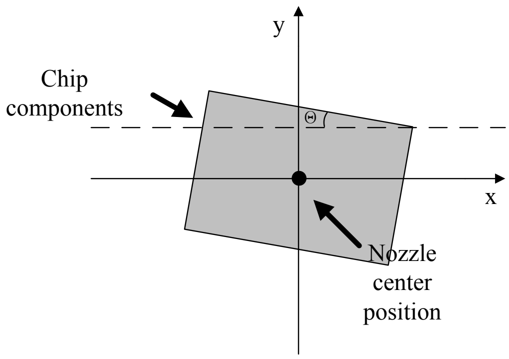


Figure 5
Chip Components in Feed Tray Angularly Offset Schematic

2.2 Correction Method

To get the angle of deviation components, it is necessary to fit a straight line boundary element. Linear least squares fitting method is a better solution (Xia & Chai, 2009; Ding et al., 2001).

Known component pin coordinates (x_1, y_1), $(x_2, y_2)\dots(x_n, y_n)$. The use of Formula (7) or Formula (4), which was fitted straight, its equation $y = kx + b$.

$$\begin{cases} k = \dfrac{n(\sum_{i=1}^{n} x_i y_i) - \sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{n(\sum_{i=1}^{n} x_i^2) - (\sum_{i=1}^{n} x_i)^2} \\ b = \dfrac{\sum_{i=1}^{n} y_i \sum_{i=1}^{n} x_i^2 - \sum_{i=1}^{n} x_i y_i \sum_{i=1}^{n} x_i}{n(\sum_{i=1}^{n} x_i^2) - (\sum_{i=1}^{n} x_i)^2} \end{cases} . \quad (7)$$

In order to facilitate programming, design Formula 3 and Formula 4 will be a combination of Formula (8) deduced:

$$\begin{cases} b = \dfrac{\sum_{i=1}^{n} y_i \sum_{i=1}^{n} x_i^2 - \sum_{i=1}^{n} x_i y_i \sum_{i=1}^{n} x_i}{n(\sum_{i=1}^{n} x_i^2) - (\sum_{i=1}^{n} x_i)^2} \\ k = \dfrac{\bar{y} - b}{\bar{x}} \\ \bar{x} = \dfrac{\sum_{i=1}^{i=n} x_i}{n} \\ \bar{y} = \dfrac{\sum_{i=1}^{i=n} y_i}{n} \end{cases} . \quad (8)$$

Where *k* is the slope of the line; *b* is the intercept of a straight line; is the average of all *x* coordinates; is the average of all y coordinates.

Coordinate points obtained in the shape matching (x_1, y_1), $(x_2, y_2)\dots(x_n, y_n)$ into the Formula (5). Obtained by Formula (9):

$$\begin{cases} b = \dfrac{(y_1 + y_2 + \dots + y_n)(x_1^2 + x_2^2 + \dots + x_n^2) - (x_1 y_1 + x_2 y_2 + \dots + x_n y_n)(x_1 + x_2 + \dots + x_n)}{n(x_1^2 + x_2^2 + \dots + x_n^2) - (x_1 + x_2 + \dots + x_n)^2} \\ \bar{x} = \dfrac{x_1 + x_2 + \dots + x_n}{n} \\ \bar{y} = \dfrac{y_1 + y_2 + \dots + y_n}{n} \\ k = \dfrac{\bar{y} - b}{\bar{x}} \end{cases} . \quad (9)$$

According to the Formula (6), and the use of inverse trigonometric functions, obtained deviation angle, as shown in Formula (10).

$$\theta = \arctan(k) . \quad (10)$$

Where θ is the deviation angle in Figure 5. By least squares straight line as shown in Figure 2 below.

3. DEVELOPMENT AND EXPERIMENT

In order to verify the feasibility of the algorithm, to build an experimental system shown in Figure 6 for the image acquisition and processing module architecture:

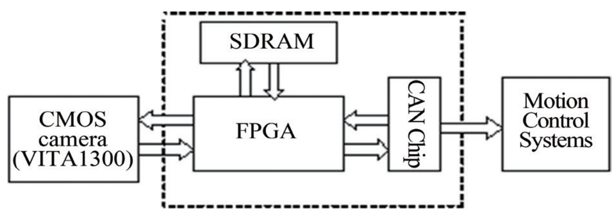


Figure 6
Image Acquisition and Processing System Architectures

System consists of CMOS camera, FPGA, SDRAM, CAN chip and motion control system. Each module is described below:

(a) CMOS camera with ON Semiconductor Model： VITA1300 NOIV2SN1300A-QDC CMOS Interface mono. Its characteristics are: CMOS sensor, Global Shutter, image resolution 1,280×1,024.

(b) FPGA using Altera's model: Cyclone IV EP4CE115F23I7. Its characteristics are: Large capacity, with a 10W LEs, the maximum operating speed of up to 400MHz, and fully apply image processing algorithms do acceleration.

(c) SDRAM using hnnix company model: HY57V641620ETP-7CAN. Its characteristics are: 4096 refresh cycles / 64ms, the maximum clock frequency of 143MHz.

(d) Microchip's CAN chip model: MCP2515. Its characteristics are: Fully supports CAN V2.0B technical specifications, the maximum rate of 1 Mb/s, and its role is systems and external communications.

(e) Motion control systems used to perform correct the deviation angle.

3.1 Algorithmic Process

System algorithm flow chart shown in Figure 7:

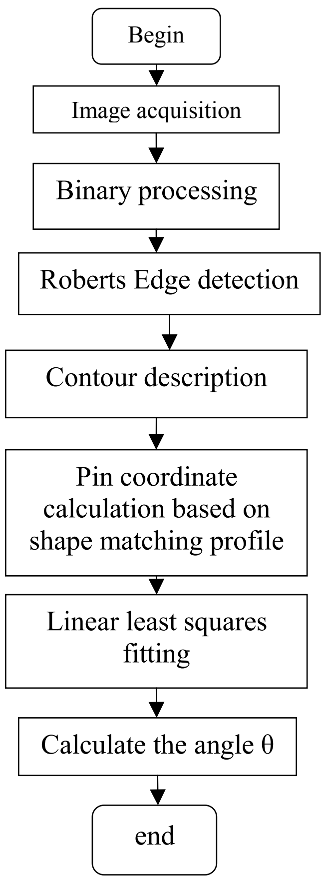


Figure 7
System Algorithm Flowchart

FPGA on the binary image acquisition processing and Roberts edge detection to obtain component pin profile. Shape matching 1.2 (b) describes the shape of the section and 1.2 (e) to give the title section of the center coordinates (Zhao et al., 2013; Jia et al., 2013). Correction Methods Section 2.2 angular deviation obtained element. Via CAN bus transmission elements deviations to the motion control system, straighten components.

3.2 Experiment

3.2.1 Fitting a Straight Line Testing Laboratories

The upper left corner coordinates of the image coordinate origin in the provisions for the image is (0,0). From left to right from the origin *X* direction, coordinate the range of 0-1,280. From top to bottom of the *Y*-direction, the coordinate range of 0 - (-1,024). Image lower right corner coordinates value (1,280-1,024). For the Figure 2(a) coordinate values shown in the test results of the pin member as shown in Table 1. Since most of the IC elements on both sides of the pin are parallel, so fitting a straight line you can get unilateral element deviation angle. Table 1 and Figure 2(a) against the upper side of the coordinate values.

Table 1
FPGA Measured Data

Component lead label	Component lead *X* coordinate/pixel unit	Component lead *Y* coordinate/pixel unit
1	559	-433
2	587	-432
3	617	-431
4	645	-430

The data in Table 1 into Equation 6 and Equation 7: b=-446.37; $\bar{x}$=602; $\bar{y}$=-431.5; k=0.0247. The deviation angle $\theta = \arctan(k) \approx 1.43°$.

3.2.2 Correction Experiment

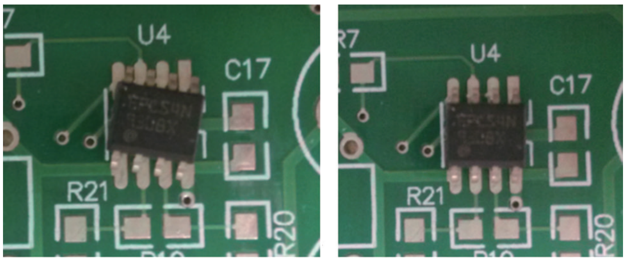
FPGA use 100MHz for a resolution of 1,280×1,024 Image Computing. Finally get each FPGA computing time is 1,280×1,024/100MHz=13.1ms. Labview calculated using the timer to give each time 300.10ms. Since the placement head of mechanical error range between -10° and 10°, so this test range is between -10° and 10°. FPGA shape matching and pattern matching Labview both computation time and accuracy of contrast, as shown in Table 2.

Can be derived from Table 2, the angle between the two comparisons: FPGA maximum absolute error of 5.13° -5° = 0.13°, Labview maximum absolute error of 10.20° -10° = 0.20°. Angle error range of modern advanced placement machine requires mostly -0.5°-0.5°. So Labview FPGA and meet modern advanced placement machine accuracy requirements. Both speed comparison: FPGA significantly faster than Labview for modern production is of great significance. Experimental results show that FPGA-based rapid correction shape matching algorithm not only improves accuracy, and computing speed has been an order of magnitude improvement.

SMD diagram elements not through correction and after correction as shown in Figure 8. From Figure 8(a) may not know quite obvious bias correction after correction as shown in Figure 8(b) to achieve the requirements of modern SMD. The algorithm is applied to high-end SMT (Surface Mount Technology) placement machine systems to meet the needs of practical application.

Table 2
FPGA and Labview Comparing the Measured Data

The actual angle value/°	FPGA measured angle value/°	Labview measuring angle/°	FPGA computing speed/ms	Labview computing speed/ms	FPGA angle absolute error/°	Labview angle absolute error/°
-10	-10.02	-10.10	13.1	300.10	0.02	0.10
-5	-4.98	-5.02	13.1	300.10	-0.02	0.02
0	0.10	-0.11	13.1	300.10	0.10	-0.11
5	5.13	5.13	13.1	300.10	0.13	0.13
10	10.05	10.20	13.1	300.10	0.05	0.20



(a) Correction ago (b) After correction

Figure 8
Element Correction Before and After Correction Element Placement Diagram

CONCLUSION

With the development of market economy, the quantity of trademark increases progressively year by year. The traditional trademark image retrieval based on classified or text labeling has a lot of problems, including the very load of manual illustration work, subjectivity, inaccuracy, etc.. Content-based image retrieval (CBIR) technology can overcome these problems, so it obtained the very widespread application in the trademark retrieval domain.

The methods of CBIR retrieve the images using the characteristics of themselves, such as color, shape, texture and the space position relations. Trademark image as an artificial image, compared with other features, shape is the most remarkable, so we always use the shape feature to distinguish various trademarks.

This dissertation focuses on the key technologies of the shape matching based trademark image retrieval, including: Trademark image segmentation technology, boundary-based shape description method, region-based shape description method, shape feature fusion and matching, sub-image multi-characteristic fusion retrieval etc. The main contributions of this dissertation can be summarized.

For PC template matching problems of slow, we propose a shape-based matching algorithm for FPGA rapid correction. The algorithm uses the FPGA will combine shape matching and least squares method instead of the PC template matching. First with Roberts operator and image convolution edge profile, then do shape matching, and finally fitting a straight line to give the deviation angle. Experiments show that, FPGA computing angular accuracy up to 0.20°, FPGA computing speed has been an order of magnitude improvement. After a lot of experimental tests, the algorithm can be applied to good corrective angle mount components, and the angle of the variable element has a good ability to adapt. The proposed algorithm can also be applied to other surface-mount placement of objects, such as diamonds and other clothing posted.

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