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Research of the SMT Product Character Segmentation Based on Contour Feature

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Abstract. The principles of the Surface Mount Technology (SMT) product character segmentation and its technology could be described as following: SMT product character image is obtained by image sampling equipment and its ideal binary images is got after image processing. In order to segment the SMT product character effectively, a novel character segmentation algorithm is proposed based on contour feature. Three kinds of information are extracted, one is the up contour feature, another is the under contour feature, the third is the width and the height of the image. Then the position of character segmentation is determined according to the width and height of single character, and character segmentation can be accomplish according to its up contour feature and under contour feature. By analyzing the test result, the proposed approach has excellent properties in character segmentation.

Introduction

The Surface Mount Technology (SMT) of Circuit Modules products (SMT product) has characters not only keeping electrical performance, but also ensuring the reliability of mechanical connection. And the Surface Mount characters (SMT Product Character) recognition is an important part of SMT products detection and control. SMT product character recognition research can formed feedback information of the products assembly which is used to control and adjust the SMT assembly, and is useful to guide SMT to improve the quality and process of SMT products. Recognition technology improved the automatic detection ability of SMT product, at the same time, promotes the development of intelligent discrimination technology [1].The result of character segmentation can affect the recognition rate of SMT product character greatly. Touching character is refers to character touching each other with stroke [2]. Touching character caused by print is very common in SMT product character [3]. There are two kinds of touching character. One is vertical touching, another is horizontal touching[4]. So the result of character segmentation is not very well based on tradition method.

The principle of the SMT product character feature extraction based on contour feature

During the SMT product character feature extraction based on contour feature, there mainly extracts three kinds of information, one is the up contour feature, another is the under contour feature [5], the third is the width and the height of the image. Before SMT product character segmenting, the image most be changed into a binary image. After that, each pix point in the image is divided into two values 0 and 1[6].

SMT product character image for the width of W, the height of H, chooses the highest point $h(i)$, the lowest point $l(i)$ in the i column. Then the up contour feature can be defined as the distance between top of the image with the highest point of the image. The calculation formula is defined as Eq. 1.

$$Top(i) = h(i) \qquad i = 1, 2, 3 \ldots W \tag{1}$$

So if no character existing in a column, the value of its up contour feature is zero. Simultaneously, the under contour feature can be defined as the distance between the bottom of the image and the lowest point of the image. The calculation formula is defined using Eq. 2.

$$Button(i) = h - l(i) \qquad i = 1,2,3...W \tag{2}$$

If there is no character in a column, the value of its up contour feature is H, and the discrete differentiation of up contour feature of SMT product character image is defined as Eq. 3.

$$DT(i) = T(i+1) - T(i) \qquad i = 1,2,3,...W \tag{3}$$

And the discrete differentiation of under contour feature of SMT product character image is defined as Eq. 4.

$$DB(i) = B(i+1) - B(i) \qquad i = 1,2,3,...W \tag{4}$$

During the interval between characters, up contour feature $Top(i)$ appears as convex structure, and the under contour feature $Button(i)$ appears as concave structure. The position of convex structure can be defined using Eq. 5.

$$M(k) = \begin{cases} j & k = 1 \\ j + k/2 & k \geq 2 \end{cases} \tag{5}$$

where $1 \leq j \leq W-2$, $1 \leq k \leq W-j-1$.

Concave structure can be define as $DB(j+k) < 0$, when $DB(j) > 0$. And if $k \geq 2$,then $\forall i \in (j, j+k)$, $DB(i) = 0$. So the position of concave structure can be defined as Eq.6.

$$N(k) = \begin{cases} j & k = 1 \\ j + k/2 & k \geq 2 \end{cases} \tag{6}$$

where $1 \leq j \leq W-2$, $1 \leq k \leq W-j-1$.

Based on the definition above, the convex feature and concave feature of SMT product character are obtained, and the segmentation position can be decided by inspecting the position of convex feature and concave feature of the character. Some character images, such as 4，R，H, have convex feature and concave feature itself, but it is not a touching character. In this study, we extract the width and height of single character to judge whether it is a touching character or not.

Generally, each character in SMT product character need keep has same height and the highest of them is chosen as the standard height. The calculation formula is defined as Eq. 7.

$$C_H = \max[(\overset{W}{\underset{i=1}{H}}(i)_p] \tag{7}$$

where $H(i)_p$ is the height at P during SMT product character string.

By experience, the constraint condition of inspection is defined as Eq. 8.

$$0.5C_H \leq C_w \leq 0.85C_H \tag{8}$$

where C_H is the height and C_w is the width of character.

In order to improve the rate of character inspection, the range of a character width is defined as Eq. 9.

$$0.6C_W \leq L_w \leq 1.5C_W \tag{9}$$

The spacing of convex feature can get from Eq. 4 and Eq. 5 and be shown as Eq. 10:

$$DM(i) = M(i) - M(i-1) \qquad i = 2,3,4....m \tag{10}$$

So m positions of convex feature can build a set $\{DM(1), DM(2), ..., DM(m)\}$. The spacing of concave feature can get from Eq. 4 and Eq. 5 and be shown as Eq. 11:

$$DN(i) = N(i) - N(i-1) \qquad i = 2,3,4....n \tag{11}$$

Then n positions of concave feature can build a set $\{DN(1), DN(2), ..., DN(n)\}$.

By inspecting the positions of convex and concave feature, and judging single character whether it meets the constraint condition L_w, we can judge the position of single SMT product character and segment them.

SMT product character segmentation algorithm based on contour feature

According to the principle of the SMT product character feature extraction based on contour feature above, a SMT product character segmentation algorithm is proposed based on contour feature. The process can be shown as Fig. 1.

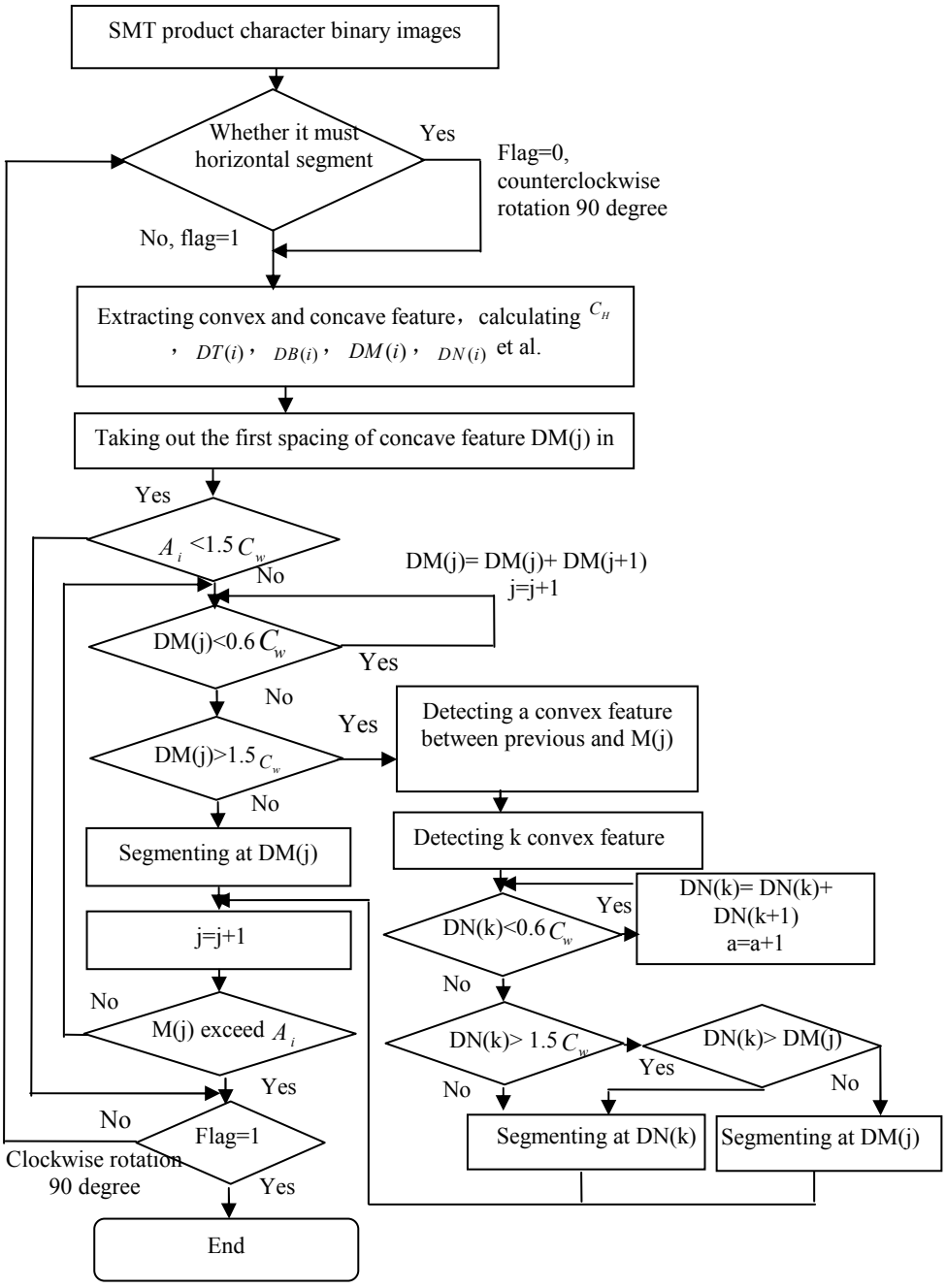


Figure 1. The process of SMT product character segmentation algorithm based on contour feature.

As Fig. 1 shows, when SMT product character is vertical touching, the image is done counterclockwise rotation 90 degree firstly, and then segmented horizontally. After that, the image is done clockwise rotation 90 degree. According to the width of image, we can judge the image whether it is vertical touching or horizontal touching. Define a flag, if flag=0, segment the character horizontally, if flag=1 segment the character vertically.

SMT product character segmentation results

Taking a computer main board MSI 845PE Max (MS-6580 Ver2.0) as sample, SMT product character can be obtained with the used of image sampling equipment. Binaryzation image of SMT product character are shown as Fig. 2 .According to the principle of the SMT product character feature extraction based on contour feature above, we can get the left and right feature of the character in Fig. 1. The results are shown as Fig. 3.

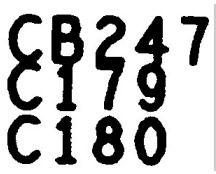
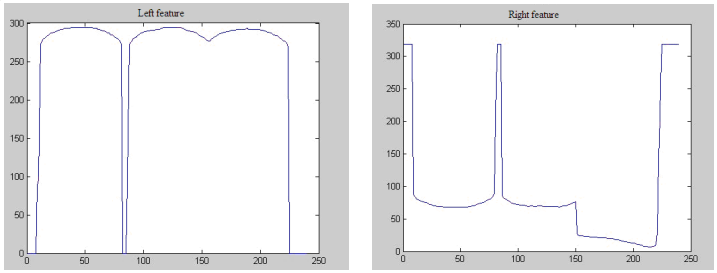


Figure 2. SMT product touching character



(a)left feature (b) right feature

Figure 3, SMT product character contour feature

According to the algorithm of the SMT product character segmentation based on contour feature above, we can segment the characters in Fig. 2. The results are shown as Fig. 4.

Figure 4. The result of SMT product character segmentation

We can see from Fig. 4and find that the touching characters are segmented effectively. When the characters are not touching, it can be segmented with the used of proposed approach. Get another SMT product character image from a computer main board MSI 845PE Max (MS-6580 Ver2.0). Its Binaryzation image is shown as Fig. 5. According to the proposed approach above, we can segment the characters effectively and the results are shown as Fig. 6.

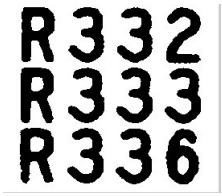


Figure 5. SMT product character

Figure 6. The result of SMT product character segmentation

Conclusions

At present, the character segmentation is the hot topic in signal process, and produces lots of new algorithm about it, but very few of them introduce SMT product character segmentation. The principle of realization method and process of SMT product character segmentation based on contour feature is introduced in detail. The test results proved that, with the use of proposed approach, we can we can segment SMT product characters can be segmented effectively. And the method has theoretical importance and practical engineering application value.

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