Hot Stamping Blank Position Detection System Based on Infrared Image

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Abstract. In order to detect whether the blanking position of the hot stamping blank is correct, an infrared detection system for the position of the high temperature blank is developed. This infrared image of the production process is obtained by the thermal imager. Based on the temperature difference between the blank and the surrounding environment, the target recognition of the blank is realized by using the optimal threshold algorithm. The experiment obtains the correct blank position data, and uses the relevant algorithm to establish the criterion of blank safe position, so as to alarm or stop the line when the parts are not placed correctly, save raw materials and ensure product quality.

Keywords: Hot stamping · Infrared image · Position detection

1 Introduction

Due to the demands of automobile lightweight, energy saving and emission reduction, hot stamping technology plays an increasingly important role in enterprise production. In the process of hot stamping, in order to ensure the product quality, the position and temperature of sheet metal should be detected. The two detection requirements require the same hardware platform, so the two detection schemes can be integrated into a detection system. Because the integrated system involves many contents and is complex, the detection of blanking position of hot stamping blank based on infrared image is mainly discussed. The detection technology based on image processing has the advantages of fast speed, high precision and easy automation. It is widely used in the fields of mechanical position, geometric dimension, surface defects and so on in industrial production. In the automatic production process of hot stamping parts, the blanking manipulator transfers the high-temperature blank to the press station. Due to the influence of production environment or external force factors, the placement position of the blank may deviate. We need to use a computer to detect whether the blanking position of the hot stamping blank is correct [1].

Infrared thermal imager is an instrument that uses infrared to show the infrared radiation energy of the measured object in the form of pictures. The images formed by it represent different temperatures on the surface of the object through different colors. In the process of hot stamping production, some parts have complex structures, and the

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ambient light, temperature and surrounding objects will interfere with the target detection to a certain extent. The detection algorithm based on infrared image can effectively suppress the background area in the image, avoid the interference of light and surrounding objects, and improve the accuracy of detection [2]. Because the temperature of the sheet metal is much higher than the ambient temperature, it is easier to find the position of the part, so as to detect its position and judge whether the template material is placed correctly. Filter and denoise the image, threshold segmentation, extract the image contour and other operations, convert the distance and pixels, and judge whether the position of the part is correct through the coordinates of the pixel center of the part area and other indicators.

2 Process of Part Target Extraction

The algorithm processing flow of infrared image is shown in Fig. 1.

Due to the low resolution of the infrared camera and the interference of various signals in the process of image transmission, the image produces noise, which has a great impact on the subsequent processing. Image smoothing can not only remove the noise in the image, but also retain the original information of the image and enhance the contrast and signal-to-noise ratio of the image. We use bilateral filtering to smooth the infrared image we obtained. The results are shown in Fig. 2b. Bilateral filtering not only prevents the loss of contour information, but also ensures the clear edge of the image. This method can be used for image denoising.

Threshold segmentation is the most basic method of image processing. Global threshold segmentation is to segment an image using a fixed threshold on a picture. Otsu method can directly give the best segmentation threshold. If the gray value of a pixel is greater than the threshold, it is set as white; if the gray value of a pixel is less than or equal to the threshold, it is set as black. Traversing every pixel in the image, we get a binary image with clear segmentation of the target and background [3]. The segmentation result of this method is shown in Fig. 2c. Because the background of the picture is simple, it will not be affected by the ambient light, and the gray value difference between the image target

Fig. 1. Image processing algorithm flow.

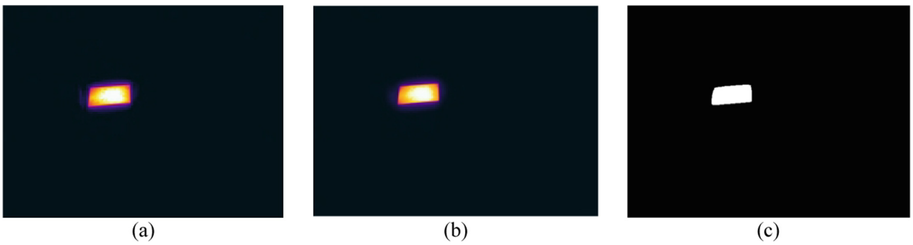


Fig. 2. Original image (a), bilateral filtering result (b) and Otsu threshold segmentation result (c).

and the background pixel is very obvious, so the global threshold segmentation method is simple and efficient. Otsu method can help us select an optimal global threshold, and Otsu method is better for threshold segmentation.

Because the points returned by edge detection are discontinuous and the position is uncertain, and the contour moment represents the global feature of an image. The moment information includes the geometric features such as the size, shape, position and angle of the target. The center of gravity coordinates of the target are obtained through the image moment, and the center of gravity coordinates of the offset position are compared with the reference position, so as to judge whether the sheet metal position is offset [4].

3 Experimental Design

3.1 Acquire Infrared Image

The position detection system of hot stamping parts based on infrared image mainly includes the calibration of visual detection system, the infrared image acquisition of hot stamping high-temperature blank, the position detection information of high-temperature blank and so on. Therefore, we should first design experiments to obtain image data, and then study the relevant algorithms according to the experimental data.

The experimental environment shown in Fig. 3a is built according to the placement position of the thermal imager in actual production. For position calibration, place the high-strength steel plate as shown in Fig. 3b at the specified position as the reference position of high-temperature steel plate. Take the vertex of the upper left corner of the reference position as the reference point, move down and left a certain distance respectively, and repeat the position calibration. Heat the high-strength steel sheet with a heating furnace and move the sheet to the specified position. Take infrared images of different positions of sheet metal parts respectively.

3.2 Get Location Detection Data

The image processing process described above is integrated into the temperature detection system to calibrate the reference position. When the reference position is offset,

(a) (b)

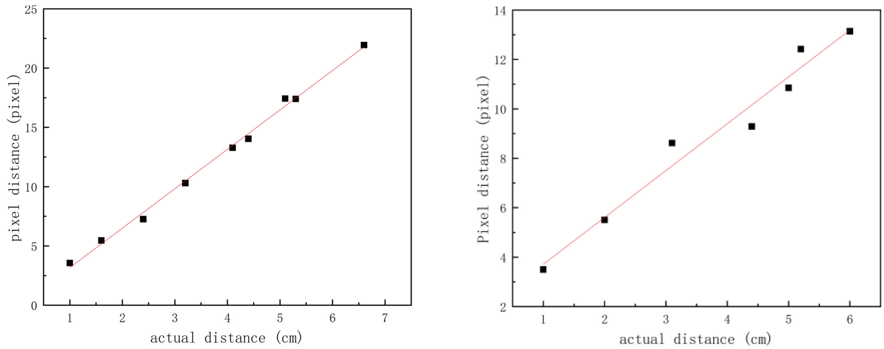
Fig. 3. Construction of experimental environment (a), high strength steel sheet (b).

Table 1. Actual distance DX and pixel distance DX in X direction.

DX	1 cm	1.6 cm	2.4 cm	3.2 cm	4.1 cm	4.4 cm	5.1 cm	5.3 cm	6.6 cm
dx	3.56	5.46	7.26	10.3	13.28	14.04	17.43	17.4	21.94

Table 2. Actual distance Dy and pixel distance dy in Y direction.

DY	1 cm	2 cm	3.1 cm	4.4 cm	5 cm	5.2 cm	6 cm
dy	3.5	5.51	8.62	9.29	10.85	12.42	13.14



(a) (b)

Fig. 4. Linear fitting of horizontal (a), vertical (b) actual offset distance and pixel offset distance.

the pixel value of the offset of the target gravity center can be directly read. Place the high-strength steel sheet at the specified position, and record the edge of the sheet as the reference position. Then expand the edges and mark these expanded rectangular boxes respectively. Heat the high-strength steel sheet and place it at the reference position. After the system is calibrated, place the sheet at the four edge positions of the box expanded by 1 cm, and record the pixel offset distance returned by the system. Repeat the appeal operation for the remaining boxes to get the data as shown in Tables 1 and 2.

3.3 Determine the Position Detection Criteria

The horizontal and vertical actual offset distances and pixel offset distances are fitted respectively, and the fitting results are shown in Fig. 4. From the fitting results, it can be seen that the actual offset distance and pixel offset distance are linear, that is, a functional relationship, and an empirical formula can be obtained. According to the given actual allowable deviation value, after the horizontal and vertical criteria are calculated by empirical formula, it can be judged whether the placement position of the sheet metal in the input picture is correct.

Table 3. Lateral actual offset distance and corresponding pixel offset distance in 9 regions.

	1	2	3	4	5	6	7	8	9
Dx1	2.7	2	2.2	2.2	2	2	2.1	2	2
dx1	6.81	5.95	5.77	8.18	7.17	7.58	9.88	9.54	8.54
Dx2	4.7	4	4.1	4.1	4.2	4	4.1	4	4.4
dx2	13.57	11.97	11.41	15.08	14.97	14.69	18.85	19.36	19.04

Table 4. Actual vertical offset distance and corresponding pixel offset distance in 9 regions.

	1	2	3	4	5	6	7	8	9
Dx1	2	2	2	2	2	2	2	2.1	2.1
dx1	3.46	2.78	3.11	5.14	5.05	4.96	8.25	6.48	7.72
Dx2	4	4	4	3.9	4	4	4	4	4
dx2	6.41	5.67	5.9	9.3	9.26	9.48	16.05	11.78	14.79

3.4 Experimental Verification

Since the above experimental results can only represent that the actual offset distance and pixel offset distance at this position on the workbench are linear, in order to obtain the relationship between the actual distance and pixel distance at more positions and verify the feasibility of our criterion method, we repeated the experiment in 3.3 for other positions on the workbench, and the obtained data are shown in Tables 3 and 4. Through denaturing fitting of the obtained data, it is found that the two variables at each position on the workbench are very close to the primary function relationship.

4 Conclusion

In this paper, an experimental scheme is designed to restore the perspective of the thermal imager in the actual factory, and take infrared images when the sheet is placed correctly and wrongly. Obtain image data and remove image noise. Then the image is segmented by threshold, the target is separated from the background, and the image contour is characterized by moment feature method. In order to find the basis for judging whether the position of the sheet metal is offset, the experiment is designed. The system obtains the pixel offset distance corresponding to the actual offset distance, analyzes the data, and concludes that the two are in a functional relationship. We can get the allowable distance of pixels according to the actual allowable distance, and take the allowable distance of pixels as the criterion, we can judge whether the position of sheet metal is correct. This set of position detection related algorithms is integrated into the temperature detection system, and experiments are designed to test the feasibility of the algorithm process, so as to complete the detection of product position.

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