УДК 621.923-5

基于视觉识别的钢包底吹氩控制模型开发

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Summary. *This paper briefly describes the application of visual recognition in the process of refining molten steel by blowing argon at the bottom of ladle. Starting from the basis of metallurgy, cross information science, to a point to try to extend the exploration of a facet of practice.*

As a traditional industry, metallurgical industry has a great demand for emerging technologies. It is difficult to modernize the key step of metallurgical production, argon blowing at the bottom of ladle. In actual production, it has been proved that argon flow is difficult to be accurately controlled, resulting in unnecessary argon loss and poor stirring effect.

As a kind of automatic recognition technology, image processing system will be beneficial to improve production efficiency and production comfort if it is applied to industrial production. Based on the current model of argon blowing in ladles, we optimized the current semi-automatic argon blowing system in ladles by contacting the visual recognition system introduced into China in the 1980s.

First, we collect the data of the factory's production conditions. The images of argon blowing at the bottom of the ladle were collected by a pre-installed high temperature industrial camera, and the images were returned to the front end for processing of the batch core code. The image collected by the industrial camera is a color image, and the color image is composed of three basic colors: red (R), green (G) and blue (B), which makes the recognition calculation complicated. In order to make the recognition simpler and more efficient in the detection process, the image should be gray processed first. In this case, we're using the means method.

In the actual working conditions, the collected data will have many factors that make the identification error. The process of eliminating these factors is called noise processing. The method of Gaussian fuzzy is adopted in this system. The principle of fuzziness can be understood as setting each pixel as the mean of the pixels in its surrounding field. The mean can be the average, median, etc., as shown in the following diagram.

The value of the center pixel in the left picture is 2, and the pixels in the surrounding 3×3 fields are all 1. Take the average value as 1 and set it to the value of the center pixel, which becomes the form of the right picture.

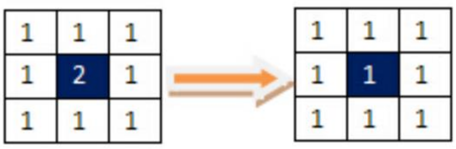

Figure 1 – Pixel

This simple average blur is obviously unreasonable, because in fact an image is basically continuous, which also means that the more adjacent pixels have a closer relationship with each other and the weight should be higher, and the more distant pixels have a more distant relationship with each other, and the weight should be lower. So we should use the weighted average method to blur.

The normal distribution is a bell-shaped curve, so the closer you are to the center, the larger the value, and the smaller the value. The two-dimensional Gaussian function is formulated as follows.

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

In order to calculate the weight matrix, it is necessary to set the σ fuzzy radius. Assuming $\sigma = 1.5$, the weight matrix with the fuzzy radius of 1.5 is as follows:

0.0453542	0.0566406	0.0453542
0.0566406	0.0707355	0.0566406
0.0453542	0.0566406	0.0453542

Figure 2 – Pixel

Since the weight values do not add to one, the matrix obtained after normalization is as follows:

0.0947416	0.118318	0.0947416
0.118318	0.147761	0.118318
0.0947416	0.118318	0.0947416

Figure 3 – Pixel

After Gaussian blur, we need to set the threshold of the image and binarization the image, so that the image only has two colors: black and white. Finally, morphological denoising is carried out to complete contour detection. In the end, we all identified the following results:

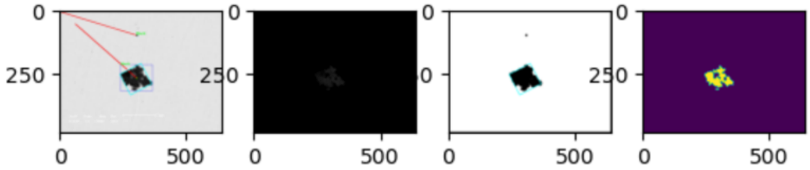

Figure 4 – Result

According to the image processing results, we can know the following points:

1. There is little difference in using the same threshold for different on-site image shooting processing situations. If the accuracy is to be further improved, the deep learning neural network can be used to find the best threshold.

2. Some black noise points outside the slag hole were preliminarily judged to be part of the slag hole even in the first step of detection, but they were not considered into the scope of the slag hole later. This is because the open operation was used, and the noise area was corroded by the open operation because it was too small.

3. When shooting on the spot, the influence of noise should be reduced as far as possible, and the industrial camera lens should be fully wiped, or a more accurate photoreceptor should be adopted, and the shooting method of short time exposure should be adopted.