

# Research on Weld Location Algorithm based on Active Shape Model

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**Abstract.** In order to improve the welding quality and avoid the welding deviation, a weld seam location algorithm based on active shape model is proposed. The local feature model is set up to detect the image, and then each feature point is used to construct the local feature. Finally, the new location of the model is searched. In the experiment, the training samples are selected to model, and the test samples are used to search and locate. By comparative experiments show that the proposed algorithm has the characteristics of high accuracy, small error, and can meet the requirements of the accuracy of the laser weld positioning system.

## Introduction

Along with the construction and development of China's modernization, the welding process will be more and more important. Centerline extraction method and curve fitting method are commonly used in welding seam location. The method of extracting the peak value of the gray level distribution curve is used in the centerline extraction[1-3]. Curve fitting method using Hof transform, least squares method, wavelet analysis and other algorithms, the running time is short but the accuracy is poor[4-7].

The issues involved in order to solve the above algorithm, this paper presents an algorithm based on active shape model is used to weld positioning. Firstly, the feature model is constructed according to the characteristics of the weld image, and the local features of the feature points are constructed and searched. Thus the welding seam detection is realized.

## Algorithm Description

**Established the Shape Model.** In this paper, the "V" shape weld is taken as an example, and the N weld image is selected as the training data. Manually mark the N feature points for each image, as shown in Fig. 1.

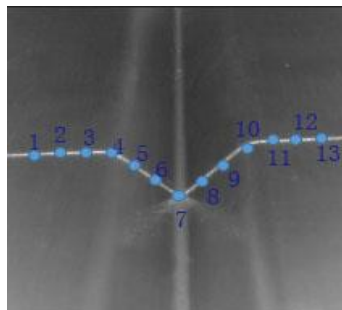


Figure 1. Manual marking feature points

The shape vector is marked as:

$$S_i = (x_{i1}, y_{i1}, x_{i2}, y_{i2}, \dots, x_{in}, y_{in})^T \quad i=1, 2, \dots, n, \quad (1)$$

After constructing the shape vector of the training set, the shape normalization is used to eliminate the interference of the external factors, then the principal component analysis is used to reduce the dimension of the vector data, and the shape model is established.

**Build Local Features.** The local feature model of each feature point is needed to find the new location of each feature point[8]. To establish a radius of M pixels of the circle around the feature point I, the circle in the threshold value of 0 pixels to the central point of the feature point I do the direction vector:

$$g_{ij} = (g_{ij1}, g_{ij2}, \dots, g_{ij(2m+1)})^T \quad (2)$$

The local feature of each feature point is obtained.

$$C_{yi} = \frac{1}{N} \sum_{j=1}^N \left( y_{ij} - \frac{1}{N} \sum_{j=1}^N y_{ij} \right) \left( y_{ij} - \frac{1}{N} \sum_{j=1}^N y_{ij} \right)^T \quad (3)$$

**Test Sample Search.** The active shape model search process is as follows[9-10]:

(1)The initial shape is obtained by affine transformation.

$$X = M(s, \theta)[a_i] + X_c \quad (4)$$

(2)The Mahalanobis distance is used to measure the similarity between a new feature g of a feature point and a well trained local feature  $C_{yi}$ . The center point of the local feature of the minimum Mahalanobis distance is the new location of the current feature  $S'_i$ .

(3)Adjust the parameters of the  $d_s, d_\theta, d_{X_c}$  and  $d_{Y_c}$ , makes the position of the current feature point X and the new position of the corresponding  $X + dX$  is closest. The search process is ended when the parameters of the affine transformation are not very large.

To sum up, the experimental flow chart of the algorithm is as follows:

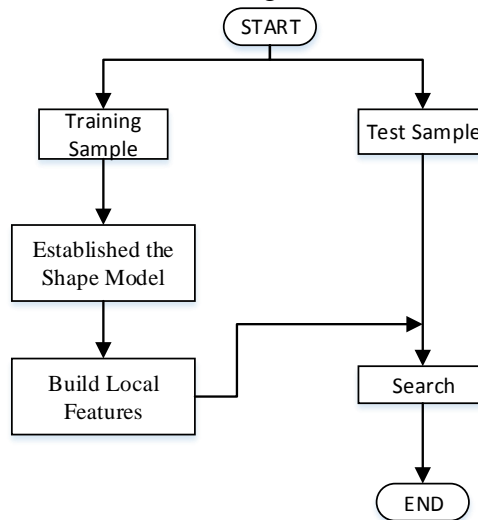


Figure 2. Flow Chart of Experiment

## Experiment and Analysis

In this paper, the author use the Qt platform and the Opencv library for weld detection experiment. We use the laser triangulation method to take 100 pictures as the weld samples. 80 of them were used as training library, and the other 20 were test samples. The test results of the algorithm shows in Fig.3.

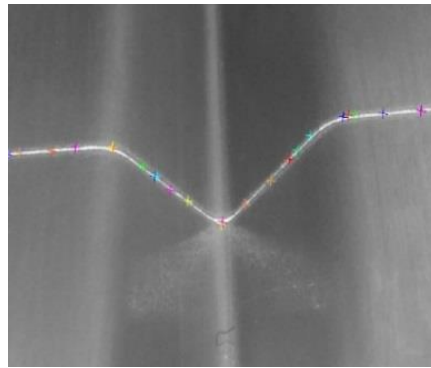


Figure 3. The Detection Results of this Paper

Using the curve fitting and centerline extraction of two kinds of welding seam detection methods to deal with the weld image as shown in Fig. 4.

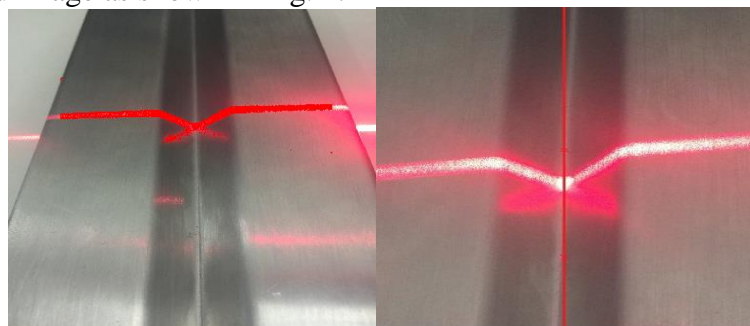


Figure 4. Effect of Traditional Laser Welding

In this paper, the average positioning accuracy is used to measure the positioning results of the algorithm. The results show that the feature point deviation is correct in 3pixel, and the proportion of error in 3pixel is :

$$E = \frac{1}{N} \sum_{i=1}^n \left[ \frac{1}{n} \sum_{j=1}^n Is(err_{ij} \leq 3) \right] \quad (5)$$

According to the comparison and analysis of the traditional method of welding seam location and the algorithm of this paper[11], the accuracy of the weld location is calculated and compared according to different algorithms, as shown in Table 1 and Fig. 5 According to the running time of different algorithms, the results are shown in Table 2, and Fig.6.

Table 1 Average positioning accuracy of test samples under different algorithms

Test sample	Average positioning accuracy		
	Paper method	Curve fitting method	Centerline extraction method
Pic.1	0.922	0.904	0.857
Pic.2	0.936	0.894	0.846
Pic.3	0.924	0.883	0.852
Pic.4	0.942	0.912	0.844
Pic.5	0.932	0.895	0.863
Pic.6	0.933	0.906	0.851
Pic.7	0.926	0.911	0.839
Pic.8	0.914	0.885	0.855
Pic.9	0.934	0.901	0.871
Pic.10	0.932	0.898	0.863

Table 2 Comparison of test running time under different algorithms

Test sample	Running Time[s]		
	Paper method	Curve fitting method	Centerline extraction method
Pic.1	0.9	1.5	1.1
Pic.2	0.8	1.3	0.8
Pic.3	1.0	1.7	1.2
Pic.4	0.8	1.4	1.0
Pic.5	1.0	1.3	1.1
Pic.6	0.9	1.5	1.3
Pic.7	1.1	1.3	0.9
Pic.8	1.0	1.6	1.0
Pic.9	0.9	1.5	1.1
Pic.10	0.8	1.4	0.9

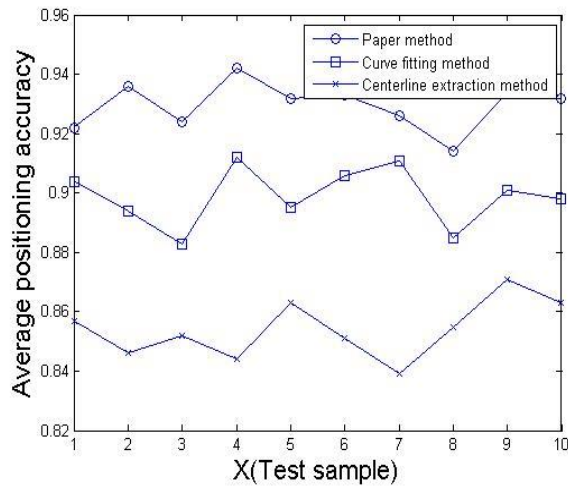


Figure 5. Experimental Results of Positioning Accuracy under different Algorithms

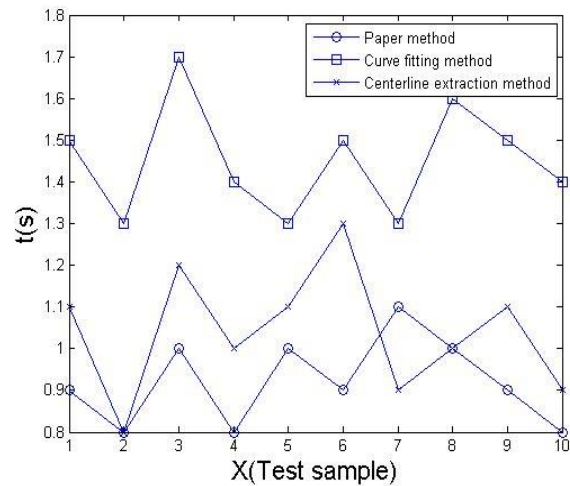


Figure 6. Comparison of Running Time

By comparison with experimental data shows that weld positioning method of active shape model than curve fitting and the centerline extraction location accuracy is higher. The running time of the algorithm is much lower than that of the curve fitting, and the most of the run time is less than centerline extraction.

According to the comparison of the two methods, the welding seam location method of active shape model presented in this paper has the advantages of high precision and short time.

## Conclusion

This paper presents a new method for laser weld location. The feature model is built and the local features of the feature points are constructed. Then the feature model is used to search the new image to get a new position. From the qualitative and quantitative analysis of two different points of view, it can be concluded that the proposed method has shorter running time, strong anti-interference ability and higher accuracy.

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## References

- [1] Xinfeng Gao. Fuzzy control based on the seam tracking system [J]. Control Engineering, 2016,01:149-152.
- [2] Cun Liu, Jinlong Liu, Yanhui Guo. A method of seam tracking based on cross correlation technique [J]. Journal of Shenyang University of Technology, 2007,05:571-573 600
- [3] Haoyi Sun, Dongtai Liang, Guoping Li, et al. Welding seam recognition algorithm based on filter [J]. Laser and Infrared, 2016, (): 1006-1013.
- [4] Ronghua Lu. Identification and location of laser welding initial point based on computer image [J]. Foundry Technology, 2016 (7): 1551-1554.
- [5] Puxian We. welding seam recognition algorithm of image based on block features [D], Xi'an University of Science and Technolog , 2014.
- [6] Huanwu Cong, Fujuan Guo, et al. Research on the technology of welding seam recognition based on CCD image processing [J]. Electronic Measurement Technology, 2012, (): 73-77.
- [7] Liting Wang, Xiaoqing Ding, Chi Fang. A robust method for automatic facial feature location [J]. Automation, 2009, (): 9-16.
- [8] Jia Yi, Bilin Wang, Shuxiu Liu, et al. Study on the method of face location based on ASM algorithm and edge detection [J].Information System Engineering, 2015 (12): 125-127.
- [9] Wu J, Mei L. A face recognition algorithm based on ASM and Gabor features of key points[C]//2012 International Conference on Graphic and Image Processing. International Society for Optics and Photonics, 2013: 87686L-87686L-6.
- [10] Yan Z, Ge H, Liu Z. The Study on Face Contour Description Based on ASM and Semantic Techniques[M]//Future Information Technology. Springer Berlin Heidelberg, 2014: 385-390.
- [11]Behaine C A R, Scharcanski J. Enhancing the performance of active shape models in face recognition applications[J]. IEEE Transactions on Instrumentation and Measurement, 2012, 61(8): 2330-2333.