Research on Image Process and Tracing of a Welding Robot

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Abstract. This paper designs a way to process image of crawling welding robot (CWR). With CCD sensors to capture man-made mark in interfering circumstance, we adopt and compare different image processing methods to extract useful information, including target location, edge extraction and centerline extraction. Beside this, we develop a controlling software with this image processing method and trace a man-made mark with the CWR. Result of tracing experiment shows that CWR can find and reach the mark precisely in welding circumstance.

1 Introductions

With many merits, for example, precise sensor in danger and invisible circumstance, vision technology are used widely in many areas, including medical area, remote area and manufacturing area and so on. Therefore, vision technology and vision sensor technology become research hot in our welding auto manufacturing area, especially in welding seam-tracing area.

But in welding robot area, there are three kind of sensor to tracing welding seam according to their sensors structure. One is arc sensor, the second is contact sensor and the last one is non-contact sensor [1-2]. Of these three kinds of sensors, arc sensor adopts variety of arc's parameters as tracing information. This tracing sensor doesn't need to add special sensor, it has best good real ability and flexibility and reachable ability. But this arc sensor has shortage that it is difficult to have a precise model between welding current variety and arc length. Another thing is difficult to check welding seam information when length of welding seam is short less 2-3 millimeter [3]. Contacting sensor adopts inching switch to judge polarity of deviation. Although this sensor has merit of simple structure and easy operation and no influence from welding soot and splash, it gets easily abrasion and distortion and so on. Ultrasonic sensor is a advanced welding seam tracing sensor with good real controlling ability, but its function is limited obviously by welding way and work piece size because ultrasonic sensor is need to stick close to work piece surface. Vision sensor is a new sensor for welding area, comparing with the three kind sensors, it has more information and flexibility and measure precise. Another obvious merit is that this vision sensor has strong power to resist influence of electromagnetism field and good adaptation ability in different welding situation [4].

T.-J. Tarn et al. (Eds.): Robotic Welding, Intelligence and Automation, LNEE 88, pp. 253–259.
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Although moving welding robots have the ability to weld large-sized work piece automatically at present, there is still a problem that this device cannot identify welding seam precisely. This identification influences welding quality directly. Therefore, it is an import thing of image process in large-size ship welding area with welding robots.

2 Hardware System

CWR system adopts CCD sensor to capture image of man-made target and processes this image with designing way, and then calculates place between robot and man-made target. After this, the system gives information to left and right motors to run and reach the target with a designed path. The hardware layout of CWR system is listed as Fig. 1.

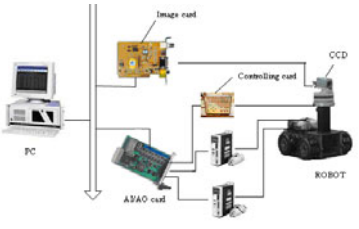


Fig. 1. Hardware layout

3 Image Pre-process

Because it is difficult for CWR finds initial welding seam directly, in this paper we design a man-made T format target and place the target in the CCD area, then the CWR can find the target. The only thing for CWR is that the robot should find the initial pot of T target and reach the pot. T format target is listed as Fig. 2.

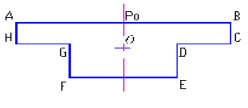


Fig. 2. Shape of target image

In order to identify man-made target from other interfering things, we design a pre-process way to filter other information. This pre-process way is different from image identification. We adopt an algorithm of two dimension median filter.

In this algorithm we adopts sub-matrix of pixels from initial image and find equalizing value. In order to test this way, we add some interfering information whose format are not T format. Fig. 3 is listed as below. After this process, initial image can avoid inferring noise and breaking point of shade of gray greatly. Result of process is listed as Fig. 4.

Fig. 3. Initial image

Fig. 4. Two dimension median process

4 Image Information Extraction

After pre-process, we need to have characteristic of target image by some way, so that CWR system can find information from other interfering images. According to this idea, we design image segmentation and characteristics extraction.

4.1 Image Initial Process

In this step, we adopt fixed parameter threshold to segment target image. Because intensity of arc light is very high, we adopt K=255 as threshold value in our program. Fig. 5 is a processed image by this way.

Fig. 5. Threshold segmentation

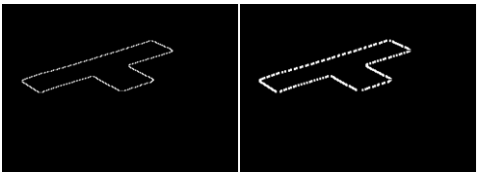
From Fig. 5, processed image includes some highlight interfering things although this threshold segmentation way can find target. In order to solve this question, we use two rules to do it. One is that regarding one connecting area [5] in image as a whole and independent area when an area has a continuous edge. Secondly, after demarcating image, we remove little connecting area that has little square measure. In this way, we design program and process Fig. 5 and find target easily.

Fig. 6. Connecting area process

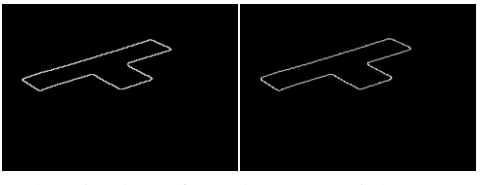
4.2 Image Characteristics Extraction

CWR system needs to find precise edge characteristics, and then this CWR can reach the right point. Classic edge extraction way takes into account change value of every pixel in some close fields. It adopts changing discipline of single-order derivative or second derivative of close fields to check image edge [6]. That is to say we can find target edge if we can use some algorithms to check the change and show it in quantifying way. Some common arithmetic operators (OA) of image edge include Roberts's OA and Prewitt OA and Kirsch OA and so on.

In order to find the best algorithm for our image edge extraction, we develop four kinds of different programs to process Fig. 6 according to above arithmetic operator. Before using these programs, T format target image has been processed by pre-process and image segmentation and connecting process. There are four results listed as below in Fig. 7 according to the four programs.



(a) Roberts (Left) and Prewitt (Right) OA



(b) Kirsch (Left) and Canny (Right) OA

Fig. 7. Edge extraction

From Fig. 7 we can see that Kirsch OA and Canny OA can give good results. Target image edge shows disconnection when processing with Robert OA. When adopting Prewit OA, target image edge shows disconnection and line width of edge becomes wider than others. Therefore we find Canny OA is a good way to process T format image in welding area.

In order to simplify welding situation, we suppose that the welding torch moves along with centerline of the welding seam all the time in the whole welding process. According to target edge information and specific welding process, CWR system just needs to orient center point or centerline of welding seam in T target image when it traces welding seam. Here we design a program to process target image Fig. 7 (b) according to Hough transformation. Our aim is to get centerline and Fig. 8 is the result.

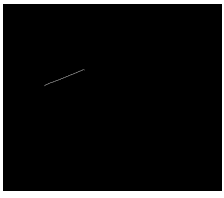


Fig. 8. Hough transformation

Therefore we design a kind of way to process T format target image with inferring information in welding situation. The series of figs are listed as Fig. 9.

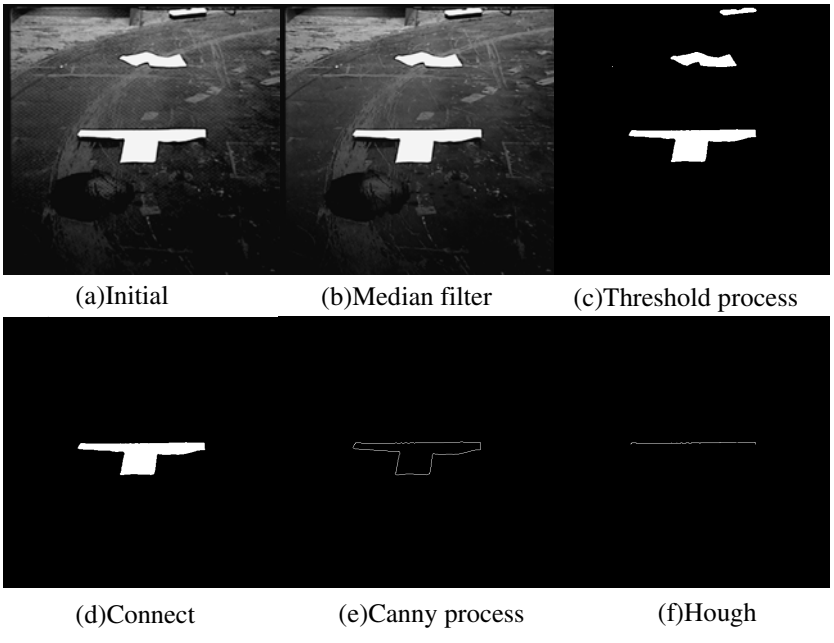


Fig. 9. Character process

5 Tracing Experiments

Here we adopt the above image processing method and develop a program to control CWR system to trace man-made target. Fig. 10 is a controlling flow of CWR system. Fig. 11 shows captured images in serial tracing steps. Experiment shows that CWR can find and reach the required place. This experiment proves image process is a good way.

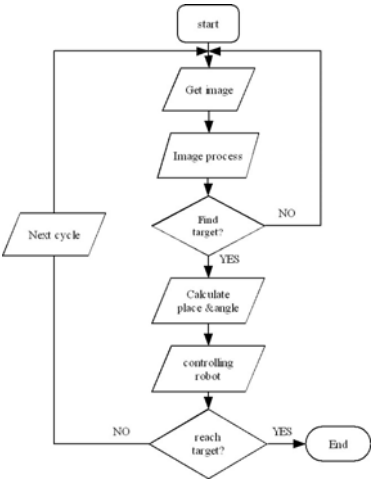
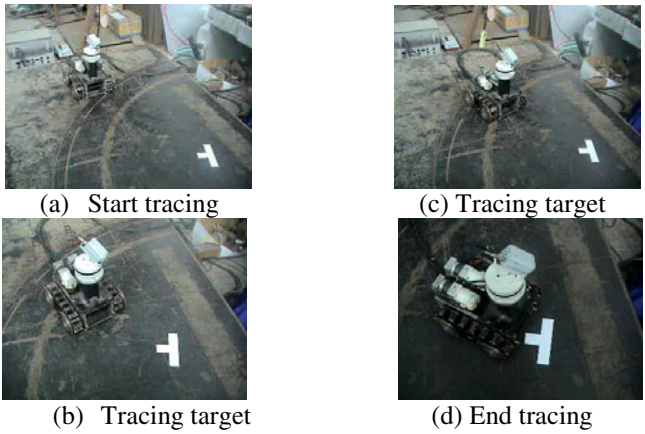


Fig. 10. Controlling flow



(a) Start tracing (c) Tracing target

(b) Tracing target (d) End tracing

Fig. 11. Different steps in tracing

6 Conclusions

In this paper a suitable way is designed to process man-made target image. This way contains pre-process and image segmentation and edge extraction. It can find the required line or point precisely and filter inferring information. Tracing experiment shows that this image process way is used well in welding situation.

Acknowledgement. This research is funded by NSFC of China (No. 50705041).

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