Research on the Robotic Arc Welding of a Five-Port Connector

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Abstract. The uncertain factors of welding process, such as the welding distortion, alternate edges in the welded seams and the variable quantity of the gap, would affect the weld appearance and quality directly. For the robotic arc welding of a five-port connector it’s necessary to establish a welding quality control system, which can realize seam tracking and welding formation control. The system captures the visual signals and the voltage signals to realize three-dimensional seam tracking. Furthermore, it stabilize the shape of the weld pool under the conditions of the varied gap and alternate edge.

1 Introduction

At present, most of the welding robots applied in the manufacturing are primarily “teach and playback” robots. The trajectory and welding parameters are preset, and the welding lacks of feedback of extraneous information and real-time control. So the traditional robotic welding needs extremely strict conditions. However in the actual welding process the environment and conditions will change inevitably. Such as welding joint location, gap and size dispersion caused by producing and machining of welding work piece, difference of trajectory by teach and actual seam, heat distortion during welding, weld penetration and formation and other factors will cause fluctuations of welding quality, and lead to the generation of welding defect [1-2]. For the welding of parts with complex structure, that require complex process, high quality and precision of welding and mass production, it’s especially necessary to adopt automatic and robotic intelligent technology which can completely replace manual welding [3].

With the development of sensor technology, arc sensing and visual sensing are applied in seam tracking. In order to achieve the high and low seam tracking control, the system captures voltage signals to obtain arc length information, and control the robot motion slider to adjust the height of welding torch [4, 5]. Vision sensing technology is widely used for seam tracking because it does not contact with the workpiece, not interfere with the welding process, and gets large amount of information and has versatility, etc. [6, 7]. Visual sensing is suitable for quality control of welding process [8-10] because it can get the two-dimensional or three-dimensional information of dynamic weld pool, that directly reflect the dynamic behavior of molten metal in the welding process.
This paper studied the methods of real-time and quality control for robotic GTAW of five-port connector based on the arc and vision sensing.

2 Deformation Prediction and Fixture Design for a Five-Port Connector

2.1 Deformation Prediction for a Five-Port Connector

Five-port connector will get distortion in the welding process because of its nature material and structure characteristics. That not only affects the size of the structure, but also reduces the local strength and stability of the structure, furthermore may affect the automatic welding quality. Therefore, scientific and quantitative prediction of welding deformation can provide important theoretical basis for subsequent welding fixture design and process optimization.

Based on elastic-plastic theory Chen Huabin [11] from Shanghai Jiao Tong University created a five-port connector finite element model by Marc software. He used the elliptical Gaussian model as a surface heat source model for simulation of the welding heat, and got the welding deformation of five-port connector. Shown in Figure 1, the weld center gets compressive stress, however residual stress of the other nodes in the weld zone is tensile stress state. Radial deformation of the weld is significantly greater than circumferential one.

![Fig. 1. Residual stress distribution for five-port connector (MPa)](image)

(a) Radial stress (b) Circumferential stress [11]

2.2 Fixture Design of a Five-Port Connector

Combined with the preceding results of numerical simulation of five-port connector, in allusion to the weld pass features of five-port connector, we designed three sets of five-port connector robotic welding fixtures. Figure 2 is the...