Chapter 64
An Optimal Image Processing Method for Simultaneous Detection of Weld Seam Position and Weld Gap in Robotic Arc Welding

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ABSTRACT

For robot path planning the weld seam positions need to be known in advance as the industrial robot generally work in teach and playback mode. In this paper, a vision sensor has been utilized for automation of robotic welding path planning. A seam tracking algorithm has been proposed for a butt type of weld joint with varying weld gap for effective measurement of weld path positions and weld gap simultaneously. For this first an image acquisition algorithm technique has been proposed for capturing of image of weld seam in gray scale mode. Then in image processing at first one pattern matching algorithm for tracking of weld seam path is performed. Then different edge detection techniques have been applied to find the most efficient edge detection method for obtaining the characteristics of weld seam edge. Then best edge fitting method has been applied to fit the edges along the weld seam edge and the pixel values on the edges were measured. The weld gap and the midpoint between edges points are measured simultaneously by vision assistant toolbox in LabVIEW software background.

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1. INTRODUCTION

Nowadays robots have been utilized for wide range of application in manufacturing industries like transportation, pick and place or manipulation etc. which basically leads to automate the system (Deepak, Parhi, & Raju, 2014; Deepak & Parhi, 2013; Deepak & Parhi, 2016). The use of robot welding operation especially industries involving assembly lines, dangerous work environment and difficult to reach position leads to automation of welding processes. The task of automating the welding operation requires sensor integration, coordination with the welding power source and motion control. In robotic welding, different sensors are utilized for automatic robot path planning for obtaining quality welds. Vision sensors have been utilized by different researchers and industries for obtaining weld seam path and also for obtaining weld seam dimensions for weld parameter control during the time of welding. For this the images of weld seam captured by vision sensors needs to be processed and analyzed in detail. Ge et al. (2005) proposed an image processing technique consisting of diagonal differencing operator for removal of noises, binarizing, and extraction of edges to find the characteristic points of weld seam for steel pipe welding. Nele et al. (2013) developed image acquisition process for automatic finding of weld seam positions. For this template matching method has been utilized for auto finding of weld start positions. Zhou et al. (2006) proposed an image processing method consisting of steps like median filtering, thresholding, thinning and feature point extraction. Similarly, an image processing algorithm has been proposed for extraction of weld seam features from the weld image following the steps like: median filtering, thresholding, Roberts's edge detection technique, thinning and non-linear square method (Shen, Lin, Chen, & Li, 2010; Shen, Lin, & Chen, 2007). Shi eta al (2007) utilized Canny operator for weld seam edge detection and further proposed an algorithm for weld seam extraction by using shift window. Chen et al. (2011) used threshold segmentation algorithm, edge detection and curve fitting for image processing to obtain weld seam features. A peak current self-adaptive regulating controller has been designed for weld parameter control during the time of welding. Kuo and Wu (2002) combined Prewitt operator with threshold method for edge detection and further applied Fuzzy method for selection of weld seam. Gao and Na (2005) proposed Kalman filtering based on centroid of weld pool image for extraction weld seam position. Dinham and Fan (2013; 2014) developed an image processing algorithm for auto-identification and extraction of weld seam characteristics. An image matching and triangulation by using two-dimensional homography method have been used for finding the results. They further developed a line growing algorithm for weld seam identification without any prior knowledge about weld seam.

From the literature survey, it has been found that different researchers have proposed different algorithms for image acquisition and image processing and in image processing, edge detection is one of the most critical step to be conducted as the weld seam position and weld groove dimensions can be obtained from weld seam edges. Though different edge detection techniques have been used for extraction of weld seam features, no comparative study has been performed for finding the better edge detection technique. Also, generally conventional gradient based edge detection techniques have been used by different researchers for weld seam edge detection. Any artificial intelligence technique like Fuzzy, neural network etc. have been not yet applied for weld seam edge detection. Also, the conventional edge detection techniques can be combined with AI techniques for getting better result. Weld gap is the distance between the two edges of weld seam. Weld gap is one of the most important parameter affecting the quality of weld. It has also found that the researchers generally considered weld seam with constant weld gap or very narrow weld gap. While in robotic welding weld gap is one of the most critical criteria affecting the quality of weld if the weld gap is varying because of rouged surface of the edge due to machining of work-pieces