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Authors: Yongzhe Li, Yunfei Sun, Qinglin Han, Guangjun Zhang, Imre Horváth

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Enhanced beads overlapping model for wire and arc additive manufacturing of multi-layer multi-bead metallic parts

Yongzhe Li[a,b], Yunfei Sun[a], Qinglin Han[a], Guangjun Zhang[a], Imre Horváth[b]

[a]State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, 150001, Harbin, China

[b]Faculty of Industrial Design Engineering, Delft University of Technology, 2628 CE, Delft, The Netherlands

Abstract: Wire and arc additive manufacturing (WAAM) is a competitive technology for fabricating metallic parts with complex structure and geometry. It enables the fabrication of multi-layer multi-bead (MLMB) parts. The basis of planning the deposition paths is the beads overlapping model (BOM). The existing overlapping models consider only the geometric area of adjacent beads, but ignore the spreading of the melted weld beads. The objective of the research was to develop an enhanced BOM (E.BOM) for WAAM, which takes the spreading of the weld beads into consideration. A deposited bead spreads to the already deposited neighboring bead and as a consequence, its center point deviates from the center point of the fed (to be melted) wire. Experiments were designed to explore the relationships between the geometries of the beads, and the offset distance between the center of a weld bead and the center of the fed wire. An artificial neural network was used to predict the offset distance of a certain weld bead based on the results of the experiments. In addition, a reasoning algorithm was implemented to calculate the optimal distance between the centers of adjacent deposition paths in order to achieve a planned center distance between adjacent beads. This enables the control of the actual center distance of the adjacent beads according to an expected value. The E.BOM has been tested by validation experiments. On the one hand, it improves the surface flatness of layers of MLMB parts produced by WAAM. On the other hand, it prevents formation of defects inside the parts.

Keywords: Additive manufacturing; Gas metal arc welding; Multi-layer multi-bead parts; Beads overlapping model; Spreading effect

1. Introduction

Additive manufacturing (AM) is a widely spread technology for fabricating metallic parts directly based on CAD models. It is often used to produce plastic parts by depositing in layers, but it is rapidly proliferating in the