Design of an integrated LMD robotic system for additive manufacturing of 3D freeform components

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ABSTRACT

Laser Metal Deposition (LMD) is an additive manufacturing process aimed to repair, coat and add geometric features on pre-existing components. Nowadays, this technology is also perceived as a method to fabricate "near net shape" large components and complex 3D shapes. Compared to the powder bed fusion (PBF) techniques, LMD can exploit further flexibility in terms of tool path programming. Layer-by-layer monodirectional scanning path commonly used in SLM is applicable also to the LMD process, but when printing overhang structures and strongly inclined surfaces, this technique shows strong limitations, due to the absence of support structures for this technology. Therefore, concerning thin-walled parts with a symmetry axis or those that evolve around an axis, more efficient deposition strategies, i.e. tool paths, need to be developed and the integrity of the final component is strongly dependent on this aspect. Hence, this work discusses the use of different part programming strategies for thin-walled structures showing complex geometries and strong overhangs employing an LMD system based on a 6-axis anthropomorphic robot and a 2-axis rotary positioner. Investigation of the influence of process parameters, build failure mechanisms during the printing, as well as geometric errors are also discussed. Successful deposition of thin-walled freeform tubular components in AISI 316L is demonstrated.