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Layer contour characterization in additive manufacturing through image binarization

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Abstract: On-Machine Measurement adoption will be key to dimensional and geometrical improvement of additively manufactured parts. One possible approach based on OMM aims at using digital images of manufactured layers to characterize actual contour deviations with respect to their theoretical profile. This strategy would also allow for in-process corrective actions. This work describes a layer-contour characterization procedure based on binarization of digital images acquired with a flat-bed scanner. This procedure has been tested off-line to evaluate the influence of two of the parameters for image treatment, the median filter size (S_f) and the threshold value (T), on the dimensional/geometrical reliability of the contour characterization. Results showed that an appropriate selection of configuration parameters allowed to characterize the proposed test-target with excellent coverage and reasonable accuracy.

Keywords: Additive manufacturing, Contour characterization, Binarization thresholding.

1. Introduction

Additive Manufacturing (AM) encompasses a series of processes capable of creating a three-dimensional geometry from bidimensional layers that are stacked vertically. AM processes can generate complex geometries without special tooling or ad-hoc fixtures, they are versatile and relatively fast since they can reduce the lapse between design and production [1]. Nevertheless, there are also some drawbacks that difficult the industrial adoption of AM. A lower geometrical and dimensional quality, especially when they are compared with material removal processes, is among those drawbacks.

Consequently, great efforts are being conducted to obtain early characterizations of geometrical and dimensional distortion of AM parts, including on-machine metrology (OMM) [2]. Among the different technologies that could be used for in-process OMM, flat-bed (FB) scanning is obtaining promising results [3]. Nevertheless, some issues like image distortion [4-6] or image processing [7] have a great influence upon the quality of contour detection, affecting the feasibility of metrological procedures based on FB scans.

The present work analyses the feasibility of using image binarization to accurately characterize layer contours in *material extrusion* (MEX) AM processes. This research analyses the relevance of two processing steps: image filtering and image binarization. A test specimen was manufactured and digitized using a commercial FB scanner. The variability of a series of quality indicators with respect to variations in two parameters, the size of a noise filter and the binarization threshold, were calculated and analysed. Image processing included several additional consecutive steps, like region filling and isolation, contour tracing and discretization, local distortion adjustment (LDA), and point clustering.

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