Design and construction of a test bench for the manufacture and on-machine non-contact inspection of parts obtained by Fused Filament Fabrication

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Abstract: Industrial application of additive manufacturing (AM) technologies is subjected to limitations related to the lack of dimensional and geometrical accuracy of manufactured parts. Many works were dedicated to improve quality of parts manufactured by AM, but integrated solutions in commercial-type AM machines have not been achieved yet. With this aim, the present work describes the design, manufacture and starting-up of a mechatronic test bench first prototype, with the double capability of 3D printing by Fused Filament Fabrication (FFF) and non-contact inspection of deposited layers. Both systems operate coordinately as the part is constructed. Final tests describe the effectiveness of both integrated systems and state the basis for further research.

Keywords: Fused Filament Fabrication, Additive Manufacturing, Non-contact inspection, On-machine inspection.

1. Introduction

Despite the great potential of AM processes in the production of complex geometry parts and non-uniform properties, industrial application of these technologies is subjected to some limitations related to economic constraints, technological limitations and, specially, the lack of dimensional and geometrical accuracy of manufactured parts. The latter is a common concern to all AM processes and, in particular, to those based on FFF, which are greatly affected by the material behaviour, the adjustment of process parameters and the construction of the AM machines.

Investigated solutions to this problem have evolved from finding of manufacturing errors and their possible causes, to works oriented to minimize them. In this way, whereas some research focused on improving parts quality by acting on the process parameters [1], others made corrections to the initial parts geometry [2] or compensations for the machine geometrical errors [3]. Despite these works, it was not possible to develop a unified model covering all error causes and their influence on the resulting geometrical inaccuracies due to the differences between AM processes. Although standardized test parts could be manufactured by different AM technologies to compare the geometrical errors obtained under each one of them (e.g., patterns for Robin rounds [4]), no conclusions could be stated drawing how to improve parts quality in each case due to the difficulty of extrapolating the results to other geometries. Another concern is that measurements are taken out of the machine, so that the reference system is missed [5]. Moreover, the experimentation required to analyse manufacturing errors is costly. The search