Contact Image Sensor integration in Fused Filament Fabrication machines for layer inspection

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Abstract: One of the limiting factors for industrial application of additive manufacturing (AM) is the lack of geometrical accuracy of manufactured parts. To improve precision, non-contact sensors should be integrated into AM machines, capable of performing in-situ inspection of the part and being able to detect and compensate for the actual geometrical errors. A non-contact digitizing system is proposed in this work for the inspection of the deposited material layers, based on a Contact Image Sensor (CIS) extracted from a commercial flatbed paper scanner. In order to integrate this sensor in an AM machine, a methodology was developed that includes the sensor operation analysis, the design of the necessary hardware and software to be externally controlled and the subsequent processing of the captured images. Results prove that the CIS sensor can be integrated in any device external to the original scanner.

Keywords: Integration, Contact Image Sensor, In-situ inspection, Digitizing, Fused Filament Fabrication.

1. Introduction

One of the main limitations of additive manufacturing (AM) is the lack of dimensional and geometrical accuracy of manufactured parts. As a solution, some authors propose the development of in-situ geometrical inspection systems and, simultaneously, the application of error compensation techniques with respect to the original CAD model [1]. Most of these works were not only scarce, but also were mainly focused on controlling and compensating for thickness deviations of the deposited layers, but not for their contour [2,3].

In any case, and as the National Institute of Standards and Technology (NIST) mentioned in a recent report, in-situ process monitoring and control represents a significant opportunity to reduce variations and ensure quality in the parts manufactured by AM [4]. In particular, to reduce the geometrical errors, it will be necessary both to develop in-situ geometrical inspection systems for the deposited layers and, at the same time, to apply techniques to compensate for errors detected with respect to the CAD model of the part. For this, it will be essential to find a suitable technology for measuring the deposited layer geometry and integrating it into the AM machine itself.

With this aim, the present work studies the feasibility of integrating a Contact Image Sensor (CIS), extracted from a commercial-type paper scanner, into an AM machine. A previous work developed by Phuc and Seitta [5], already demonstrated the capacity of this technology to digitize the material layers deposited in an AM process. In this case, the sensor was installed in the machine head and movement