Chapter 9
Applications of Image Processing Techniques in Fused Deposition Modeling

Manasa R.
Dayananda Sagar College of Engineering, India

Karibasappa K.
Graphic Era University (Deemed), India

Abhishek M. B.
Dayananda Sagar College of Engineering, India

Vibha T. G.
Dayananda Sagar College of Engineering, India

Bindu H. M.
Dayananda Sagar College of Engineering, India

ABSTRACT

3D printing uses fused plastics and composite filaments to layer components. This method produces parts for household tasks, industrial applications, and rapid prototyping. Developing a printing model requires determining extruder speed, extrusion height, and bed temperature (slicing). Poorly defined parameters can result in poor dimension precision, surface integrity, mechanical properties, and finally printing flaws in plastic and composite sections, limiting or prohibiting their use. During the first stage of 3D printing, a component's first layer is created. This chapter primarily reviews research on the use of image processing methods at different phases of the fused modeling process. Additionally, a review of the broad literature on the junction of FDM and image processing has been presented. The advantages and disadvantages of image processing for the FDM process, as well as existing barriers, have been discussed.

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INTRODUCTION

AM, also referred to as 3D, has increased immensely in popularity over the years as suggested by L. Lu, J. Zheng et al 2015 and J. Jiang, X. Xu 2019. The authors I. Campbell et al 2012 and J. Jiang et al 2019 discuss that a range of industries, which include automobiles, aerospace, and medicine, have adopted it because of its unrivaled ability to lower various design metrics, such as time-to-market, the ability to produce high-complexity as well as performance products rapidly, and the ability to mass customize. C. Kousiatza et al 2016 have told that Fused Deposition Modelling is one of the most frequently used techniques in classifying additive manufacturing processes due to the high speed, low machinery price, and durable part materials. A typical FDM process entails melting thermoplastic material, extruding plastic via a nozzle, and layering it on a worktable is given by D. Espalin et al 2014. Its observed by Q. Y. Lu et al 2018 and W. Devesse et al 2017 that the uncertainty associated with FDM printing technology continues to be a significant problem and results in geometric errors or surface defects. Provided the long and complex production cycle connected with FDM having to print, it is essential to identify flaws and failures slightly earlier in the print process to avoid wasting time and money as seen in Y. Wang et al 2019 and Y. Wang et al 2020. Numerous researchers like Y. Tlegenov 2018 have been done to forecast printer effectiveness using specific printing parameters such as part temperature, nozzle condition etc. These techniques, however, necessitate the development of precise mathematical modeling techniques to link abnormal printer parameters to specific defects. Due to the complexity of 3d - printed mechanisms, developing a comprehensive framework to identify most of the problems in practice is extremely difficult. Unlike the indirect monitoring mentioned previously, operators inspect printing components directly for defects. This way, any flaws in the appearance can be found right away. Since the parts' appearance now reflects their deviations first from the design model, their quality can be determined by their appearance. On the other hand, constantly monitoring innumerable printing processes is extremely difficult.

There are now many automated systems for monitoring the printing process parts that don't need to be monitored by humans. Its because new computer vision techniques have made it easier for these tasks to be done. Gonzalez and Woods, 2002 showed that Image processing is capturing data using imaging devices, including cameras and scanners, and converting it to a computer or even device-readable format by Russ, 2016. This field emerging image sensor manages the object's dimensions and detects its color using image processing techniques. Ultrasound, electroscope, and computer-based images were also constructed from various components retrieved from the image source to accomplish a specific task Samtaş and Gülesin, 2011.

Image processing includes three stages: transferring images to electronic media, analyzing them, and printing the results Neumann et al., 2011. The initial step, analysis, is designed to minimize noise from the image (image blur, lack of sharpness, and poor image quality). For example, low-level operations like image filtering and high-level operations like image analysis are used to achieve this Bellaire et al., 1998. Along with the image processing steps, two types of image processing are used: analog and digital image processing. Digital and analog image processing consist of the following stages: pre-processing, during which data must pass; development and visualization; but rather information and extraction Lin et al., 2018. Yuanbin Wang et al 2020, Alberto Boschetto et al 2015, Ketai He1 2018, Koray Ozsoy 2021, Yi WU 2018, Hongyao Shen et al 2020, Matheus Godoy Fonseca Carmo 2020 have discussed that Images can be processed to improve their color and light quality, enhance their clarity, store and transfer them more efficiently, and even think of all the people in them. Established research mainly focuses on part geometry and infill pattern defects. Generally, this method needs to take a moment and recreate the

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