Chapter 10
Parameters Optimization of FDM for the Quality of Prototypes Using an Integrated MCDM Approach

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ABSTRACT

Fused deposition modeling (FDM) is one of the emerging rapid prototyping (RP) processes in additive manufacturing. FDM fabricates the quality prototype directly from the CAD data and is dependent on the various process parameters, hence optimization is essential. In the present chapter, process parameters of FDM process are analyzed using an integrated MCDM approach. The integrated MCDM approach consists of modified fuzzy with ANP methods. Experimentation is performed considering three process parameters, namely layer height, shell thickness, and fill density, and corresponding response parameters, namely ultimate tensile strength, dimensional accuracy, and manufacturing time are determined. Thereafter, optimization of FDM process parameters is done using proposed method. The result shows that exp.no-4 yields the optimal process parameters for FDM and provides optimal parameters as layer height of 0.08 mm, shell thickness of 2.0 mm and fill density of 100%. Also, optimal setting provides higher ultimate TS, good DA, and lesser MT as well as improving the performance and efficiency of FDM.

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INTRODUCTION

Rapid prototyping (RP) or additive manufacturing (AM) is one of the important techniques to build a prototype for components using while product development. These components can be used in assemblies, product testing and tooling for the short or medium run production. There are various additive manufacturing processes are available which include selective laser sintering (SLS), stereo lithography (SLA), ink jet modeling (IJM), direct metal deposition (DMD), fused deposition modeling (FDM), laminated object manufacturing (LOM), solid ground curing (SGC) and 3D plotting etc. Among the various additive manufacturing processes mentioned above, fused deposition modeling (FDM) is most used additive manufacturing process for building prototypes because of the less time consuming and its ease of operation. Since there are wide applications are involved by using the FDM process, the quality of the prototypes and cost of the product development are become important factors. In many engineering applications, qualities of the prototype like surface finish, strength, dimensional accuracy are important factors. Since the properties of the fabricated products changing by varying the process parameters, the optimal combination of the process parameters is required for better quality products in both technological and economical view. So, the optimization of the FDM process parameters is required for quality product fabrication in less time. The variation of the quality and other functional properties of the fabricated products according to the usability can be done by using optimization.

The evolutionary approach, bacterial foraging technique, was used to predict the optimal parameter settings and also studied five important process parameters such as layer thickness, orientation, raster angle, raster width and air gap have been considered to study their effects on three responses viz., tensile, flexural and impact strength of the test specimen. The bacterial foraging technique is used to suggest theoretical combination of parameter settings to achieve good strength simultaneously for all responses (Panda et al., 2009). Another researcher (Mohamed et al., 2016) described the effects on build time, feedstock material consumption and dynamic flexural modulus using Q-response methodology were studied influence of critical FDM parameters are layer thickness, air gap, raster angle, build orientation, road width, and number of contours are studied. The results show that Q-optimal design is a very promising method in FDM process parameter optimization and also confirms the adequacy of the developed models.
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