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Multi-objective optimization of printing time and shape accuracy for FDM-fabricated ABS parts

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Abstract. Fused Deposition Modeling (FDM) is one of the most widely used Additive Manufacturing technologies that extrude a melted plastic filament through a heated nozzle in order to build final physical models layer-by-layer. In this research, a case study is presented in order to optimize process performance of a low cost FDM 3D printer. Taguchi method was first employed for the experimental procedure design and nine test parts were built according to L9 orthogonal array. The examined process parameters were the deposition angle, layer thickness, and infill ratio each one having three levels. Infill pattern was constant to honeycomb selection. Fabrication time of ABS (Acrylonitrile-Butadiene-Styrene) 3D printed specimens was measured during experiments and analyzed by using Analysis of Means (ANOM) and Analysis of Variance (ANOVA) techniques. Shape accuracy was measured by considering the parts' dimensions in X, Y and Z axes and expressed as the overall error for control. Regression models were developed to use them as objective functions for a group of multi-objective optimization algorithms. Multi-objective Greywolf (MOGWO), multi-objective antlion (MOALO), multi-verse (MOMVO) and multi-objective dragonfly (MODA) algorithms where implemented to simultaneously optimize the bi-objective FDM optimization problem. To evaluate the algorithms and judge superiority with reference to the non-dominated solution sets obtained the hypervolume (area) indicator was adopted. It was verified that algorithms perform differently to the problem formulated for optimizing the FDM process.

Keywords: Fused Deposition Modeling; Additive Manufacturing; ABS; printing time; shape accuracy; process optimization

1. Introduction

Globalization and keener competition among manufacturing industries has imposed the necessity to produce high-quality and low-cost products at the same time. Such volatile and competitive processing scenarios found in industry, have already drawn the interest of researchers to develop and deploy automation technologies in almost all branches of manufacturing engineering. To develop new products, it is mandatory to produce prototypes from solid models

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