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Study on Rapid Prototyping, FDM, Process Parameters to Optimize the Output Characteristics

A thesis submitted in partial fulfillment of the requirements of the M.Sc. in Mechanical Engineering.

By

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ABSTRACT

Optimization is a choice that must be made from several possible solutions while respecting a finite number of constraints. The optimization tries to improve system performance in the direction of the optimal point. In today's competitive world, to meet the market demands for products, it is necessary to reduce the design to production time as efficiently as possible. Additive rapid prototyping technologies like fused deposition modelling (FDM) have been widely employed in today's manufacturing industries such as transportation, aerospace and medical. However, in order to get the greatest quality of a printed component, careful selection of input process parameters is critical. This work introduces novel methods such as response surface methodology (RSM) and artificial neural network (ANN) for determining the optimum parameter settings for improving the surface quality of printed parts using advanced poly-lactic acid (PLA+) thermoplastic material. The input parameters were extrusion temperature, layer height and printing speed, while the responses were the surfaces roughness (Y-Plane, Z-Plane, XY-Plane, X-Surface, Y-Surface and Z-Surface). Full factorial design of four levels is used as design of experimental (DOE) trials using three input parameters providing 64 experiments. The surface roughness obtained by RSM by 96.19 percent for Y-Plane, 96.88 percent for Z-Plane, 97.22 percent for XY-Plane, 96.08 percent for X-Surface, 97.85 percent for Y-Surface and 97.70 percent for Z-Surface according to the data. There was also a good match between the predicted and the experimental value of surface roughness. The statistical analysis of the ANN result for surface roughness revealed the maximum error percentage (-2.337%), which is a good agreement and goodness of fit (R= 0.99459), (R= 0.99710), (R= 0.99866), (R= 0.99788), (R= 0.99611) and (R=0.99904) for Y-Plane, Z-Plane, XY-Plane, X-Surface, Y-Surface and Z-Surface, respectively in training. These values are acceptable in accordance with the experimental data.

DEDICATION

To the one who is dearer than my soul, my first master, the master of all creatures

Prophet Mohamed (PBUH)

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