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Optimization of Surface Roughness in Additive Manufacturing Processes via Taguchi Methodology

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Abstract : This paper studies a case where the targeted surface roughness of fused deposition modeling (FDM) additive manufacturing process is improved. The process is designing to reduce or eliminate the defects and improve the process capability index Cp and Cpk for an FDM additive manufacturing process. The baseline Cp is 0.274 and Cpk is 0.654. This research utilizes the Taguchi methodology, to eliminate defects and improve the process. The Taguchi method is used to optimize the additive manufacturing process and printing parameters that affect the targeted surface roughness of FDM additive manufacturing. The Taguchi L9 orthogonal array is used to organize the parameters' (four controllable parameters and one non-controllable parameter) effectiveness on the FDM additive manufacturing process. The four controllable parameters are nozzle temperature [°C], layer thickness [mm], nozzle speed [mm/s], and extruder speed [%]. The non-controllable parameter is the environmental temperature [°C]. After the optimization of the parameters, a confirmation print was printed to prove that the results can reduce the amount of defects and improve the process capability index Cp from 0.274 to 1.605 and the Cpk from 0.654 to 1.233 for the FDM additive manufacturing process. The final results confirmed that the Taguchi methodology is sufficient to improve the surface roughness of FDM additive manufacturing process.

Keywords : additive manufacturing, fused deposition modeling, surface roughness, six-sigma, Taguchi method, 3D printing
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