

Optimization of 3D Printing Process Parameters to Minimize Surface Roughness with Artificial Neural Network (ANN) and Harris Hawks Optimization (HHO)

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Abstract

Fused Deposition Modeling (FDM) is an additive manufacturing technique in which components are built layer-by-layer by extrusion of thermoplastic material. This technique offers the advantages of complex, customized geometries with lower material waste and production costs than conventional manufacturing. Despite these benefits, FDM often results in high surface roughness, characterized by the unevenness of a part's exterior surface. The surface roughness of the printed samples can be adversely affected by the selection of input parameters, such as infill density, printing speed, and layer thickness. This study aims to investigate the impact of these parameters on surface finish and optimize FDM printing parameters to minimize surface roughness by employing an Artificial Neural Network (ANN) integrated with Harris Hawks Optimization (HHO) method. The impact of five parameters, nozzle temperature, bed temperature, infill density, printing speed, and layer thickness, on the surface roughness of Polylactic Acid (PLA) printed parts were evaluated. The Taguchi Orthogonal Array (OA) was used to reduce the number of experiments and to optimize the process. The results of the study indicated the optimal settings for minimum surface roughness were a nozzle temperature of 219.98°C, bed temperature of 50.46°C, infill density of 37.94%, printing speed of 284.25 mm/s, and layer thickness of 0.20 mm, resulting in a surface roughness value of 2.7903 μm , upon printing the sample with the obtained optimal values, the surface roughness was measured as 4.4421 which gives an error percentage of 37.18%.

Keywords

Artificial neural network, fused deposition modelling, harris hawks optimization, surface roughness, taguchi orthogonal array.

