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Optimizing Fused Deposition Modeling with ANN: Material Consumption and Tensile Strength Predictions

Abstract

Conventional modelling was once favored for process modelling for its straightforward nature and simplicity. However, conventional modelling is incapable of modelling complex processes such as fused deposition modelling (FDM). This study aims to model an accurate FDM process using an artificial neural network (ANN) to predict material consumption and tensile strength based on layer height, infill density, printing temperature and printing speed. The design of the experiment (DOE) was constructed using face-centered central composite design (FCCCD) yielding a total of 78 specimens. The material consumption was measured by weighting the specimen using a densimeter while the tensile strength of the specimen was tested using a universal testing machine (UTM). Best ANN structures were first identified in a trained network before being modelled for comparison. Models were compared using the lowest mean squared error (MSE), root mean squared error (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE) and highest coefficient of determination (R2). The best predictive model structure for material consumption is 4-19-14-1 with the lowest MSE of 0.00096 while the best predictive model structure for tensile strength is 4-16-15-12-1 with the lowest MSE of 0.005274145.

Keywords

Artificial Neural Network; Fused Deposition Modelling; Modelling and Simulation