

Multi-Objective Optimization Model for Sustainable 3D Printing Considering Quality Loss

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Abstract

Sustainable 3D printing creates products made layer by layer that reduce pollution, save energy, save natural resources, and are economical and safe for workers, communities, and consumers. These aspects can be applied to the sustainable 3D printing process by creating a mathematical model to find optimal sustainable 3D printing process parameters. This study develops a multi-objective optimization mathematical model to find the optimal solution for sustainable 3D printing process parameters by considering quality loss. This study involved several decision variables representing geometric variables: filament diameter, process variables, printing speed, structural variables, number of layers, and layer thickness. This study has three objective functions: minimizing carbon emissions, minimizing waste, and minimizing quality loss. The Gamultiobj algorithm (MATLAB) and the Non-dominated Sorting Genetic Algorithm II method are used to search for optimal values for the four objective functions simultaneously. This study shows that considering the quality loss function, the optimal values align with reality because it considers the variability of quality and potential loss of quality in currency units.

Keywords

Sustainable 3D printing, multi objective optimization and quality loss.

Biographies

Eko Pujiyanto is an associate professor in the Department of Industrial Engineering, Faculty of Engineering Universitas Sebelas Maret Surakarta Indonesia. He is a Professional Engineer registered with Institute of Engineers Indonesia (PII). He received the B.S. degree in Mathematics in 1993 and the M.Eng. degree in Industrial Engineering in 1998, both from Bandung Institute of Technology, Bandung and Ph.D. degree in Mechanical Engineering in 2012 from Gadjah Mada University, Yogyakarta, Indonesia. He is currently a member of The Center for Research in Manufacturing System at Sebelas Maret University. His main research is the modeling and experimentation of manufacturing processes. His research interests include modeling and optimization of sustainable manufacturing process using statistical and computational, and data analysis and optimization using heuristics. In addition to research in the field of sustainable manufacturing modeling, he is also experimental-based research related to biomaterials

using the Taguchi Method. The results of the multi-response experiment using the Taguchi method were optimized simultaneously with the multi-objective optimization tool. He has authored/coauthored several papers on these subjects.

Cucuk Nur Rosyidi is a professor in the Department of Industrial Engineering, Faculty of Engineering Universitas Sebelas Maret Surakarta Indonesia. He received the B.S. degree in Industrial Engineering from Sepuluh Nopember Institute of Technology, Surabaya and the M.Eng. and Ph.D degree in Industrial Engineering both from Bandung Institute of Technology, Bandung. He is currently a Head of The Center for Research in Manufacturing System at Sebelas Maret University. His main research is the modeling of manufacturing processes. His research interests include modeling and optimization of sustainable manufacturing. He has authored/coauthored several papers on these subjects.

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