Path Planning and Fiber Angle Optimization of Continuous Fiber Composites for Additive Manufacturing

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AbstractThis study proposes an optimization framework for 3D printers to integrate the structural and the manufacturing perspectives. The recent developments in Additive Manufacturing (AM) technologies of composite structures led to the emergence of new design techniques to find innovative and more efficient solutions. The main goal of this study is to implement a path planning algorithm and optimize both the printing time and the stiffness of the produced part. A Genetic Algorithm is used as a solver to optimize a multi-objective function including the printing time and the structural performance. In terms of the structural performance, the stress and stiffness are selected as the objective function. The framework is applied for different 2D and 3D cases. The designs are obtained for two types of the continuous fiber path planning, namely straight and curvilinear fibers. The raster filling scheme is developed for the continuous deposition path planning. The results show that the fiber orientations can change significantly based on the objectives. The fiber orientation is tailored around the hole for the shell plate with the hole when the stress objective is considered. The optimal fiber path planning is also dependent to the selection of the weight factors for the printing time and the structural performance objectives. The design parameters for the calculation of the printing time can be updated according to the 3D printer specifications.

**Keywords:** Additive Manufacturing, Fused Deposition Modeling, Carbon Fiber Reinforced Plastic, Variable Angle-Tow Composites, Path Planning, Genetic Algorithm.