Filament Path Optimization with Curvilinear Trajectories for Additive Manufacturing of Load-Bearing Components

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ABSTRACT

The strong mechanical anisotropy of Fused Filament Fabricated (FFF) parts dictates us to include the filament layout in the design process, although usually discarded. The current strategy for filament path design employs Finite Element Analysis, where the filament orientation in each finite element is optimized to minimize an objective function. The resulting optimal orientation field has to be then post-processed into a set of instructions to code the filament paths. A major downside of this strategy is that there are yet no established techniques to informatively position the filaments following an orientation field and enable good agreement between the performances conceived in the design and the real time. The current work is dedicated to address this limitation, wherein a set of production-ready filament trajectories directly result from the design process. The idea is to find the optimal control parameters for an assumed level-set function whose contours describe the filament trajectories of the part to be produced. Such an approach enables easy imposition of the manufacturing considerations and locally assign anisotropic material properties as a function of the level-set parameters. Recent works [1, 2] have used uniform B-splines and streamline functions to represent the level-set surfaces. Although they obtained production-ready filament paths, only local gradient-based algorithms were used. The current work extends the same methodology to find globally optimal solutions by employing metaheuristic methods.

REFERENCES

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