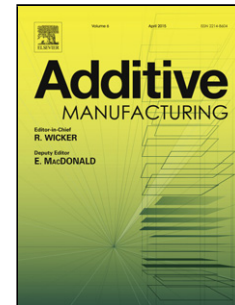


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A fast, efficient direct slicing method for slender member structures

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Abstract

This work describes a method for quickly and efficiently slicing structures consisting of a large number of slender members called struts connected at node positions called joints. Previous research on periodic lattice structures shows these structures are highly mechanically efficient with exceptionally high stiffness- and strength-to-weight ratios. Additive manufacturing technologies allow the construction slender member structures with complicated macroscale shapes. These structures could consist of thousands or millions of geometric primitives describing the struts. Structures with large numbers of geometric objects cause the conventional methods for manipulating, storing, and slicing the geometry of these parts via STL files to be highly inefficient. This work describes an alternate design process for slender member structures using efficient methods for manipulating, storing, and slicing the geometry of the part. These new methods, in particular a fast, efficient direct slicing method, enable printing slender member structures with over one hundred thousand struts. The slicing algorithm is nearly perfectly parallel so it could extend to handle structures with over one million struts, helping to facilitate the adoption of slender member structures for engineering-scale applications.

Keywords: Lattice materials, slicing methods, STL, stereolithography

1. Introduction

Additively manufactured slender member structures reduce the weight of a component while maintaining an overall macroscale shape. Recent work demonstrates the efficiency and even optimality of such structures, particularly periodic slender member lattices, in terms of structural stiffness and strength relative to the effective density of the lattice material [1–3]. Additive manufacturing processes can assemble slender member structures out of a variety of materials – polymers [2], hollow metal tubes [4], solid metal [5], and ceramics [6] and with a range of strut length scales from nanometers to centimeters. Increasing attention has been devoted to the performance and manufacture of these materials in the literature but little towards how to efficiently generate and store descriptions of the geometry of such structures and on how to produce the build

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