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# Method for Designing Ultra-Compliant Interwoven Meta-Materials

Background

Additive manufacturing has contributed to the growth of technology to fabricate structures that have enhanced performance in a wide range of applications. One example family of these structures is cellular, or meta-materials, which include honeycombs, foams, and lattices. These materials enable novel properties that exploit the nature of the design of the structure, as opposed to just the base material itself.

In nature, a glass sea sponge called the Venus Flower Basket (Euplectella aspergillum) has an external skeleton that is made up of lattices that are interwoven with each other in a particular pattern. This interweaving nature makes the structure consisting of otherwise brittle silica, more compliant.

Invention Description

Inspired by this observation of interweaving in the sea sponge, researchers at Arizona State University, Purdue University, and Kennesaw State University have developed a novel method for designing ultra-compliant lattice meta-materials with a ten-fold improvement over standard BCC (Body-Centered Cubic) lattice structures. This method involves selectively de-coupling nodes to create lattices that resemble fabric weaves in 3D. These lattices are effectively a new type of metamaterial that retains the original connectivity everywhere except where nodes are decoupled and has up to a 20-fold enhancement in compliance over the fully connected lattices they are derived from.

Potential Applications

- Aerospace and defense (e.g., soft robotics, light weight energy absorbers for protection)
- Compliant wearables
- Piezoelectric or mechanical sensors
- Footwear and sports equipment

Benefits & Advantages

- Demonstrated to improve compliance by an order of magnitude and is among the most compliant lattices every reported
- Simple design approach that can be applied to modify nearly any lattice metamaterial
- Minimal computation expense
- Does not involve joint-based mechanisms (difficult to manufacture and prone to reliability issues)