METHOD TO INVERSE DESIGN MECHANICAL BEHAVIORS USING ARTIFICIAL INTELLIGENCE

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PATENT STATUS

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Published Application	2024/253734	12/12/2024	2023-102

Additional Patent Pending

BRIEF DESCRIPTION

Metamaterials are constructed from regular patterns of simpler constituents known as unit cells. These engineered metamaterials can exhibit exotic mechanical properties not found in naturally occurring materials, and accordingly they have the potential for use in a variety of applications from running shoe soles to automobile crumple zones to airplane wings. Practical design using metamaterials requires the specification of the desired mechanical properties based on understanding the precise unit cell structure and repeating pattern. Traditional design approaches, however, are often unable to take advantage of the full range of possible stress-strain relationships, as they are hampered by significant nonlinear behavior, process-dependent manufacturing errors, and the interplay between multiple competing design objectives.

To solve these problems, researchers at UC Berkeley have developed a machine learning algorithm in which designers input a desired stress-strain curve that encodes the mechanical properties of a material. Within seconds, the algorithm outputs the digital design of a metamaterial that, once printed, fully encapsulates the desired properties from the inputted stress-strain curve. This algorithm produces results with a fidelity to the desired curve in excess of 90%, and can reproduce a variety of complex phenomena completely inaccessible to existing methods.

SUGGESTED USES

Mechanical design wherever metamaterials with complex or novel mechanical properties are desired. Examples include automobile crumple zones, running shoe soles, airplane wings, etc.

ADVANTAGES

This method is much faster and less expensive than existing approaches, taking only seconds and not requiring the expensive trial and error of other methods.The method properly accounts for manufacturing defects, which can substantially alter material properties. Additionally, the method reproduces exotic mechanical phenomena which are generally beyond the reach of existing approaches.

RELATED MATERIALS

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OTHER INFORMATION

KEYWORDS

Metamaterials, machine learning, exotic materials, nanomaterials, material design.

CATEGORIZED AS

- **Computer**
  - Software
- **Materials & Chemicals**
  - Nanomaterials
- **Nanotechnology**
  - Materials
- **Research Tools**
  - Other
- **Security and Defense**
  - Other

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