INVERSE DESIGNING METAMATERIALS WITH PROGRAMMABLE NONLINEAR FUNCTIONAL RESPONSES

Tech ID: 33823 / UC Case 2025-054-0

PATENT STATUS

Patent Pending

BRIEF DESCRIPTION

Current methods for designing metamaterials to achieve a specific, complex physical response curve are often time-consuming, computationally intensive, and struggle with precisely programming nonlinear functional responses. This innovation, developed by UC Berkeley researchers, addresses this by offering a novel, accelerated inverse design method that leverages a hybrid machine learning approach combining imitation learning and reinforcement learning with Monte Carlo tree search (MCTS). This unique combination allows for the rapid and precise generation of metamaterial structures that meet a plurality of target physical response features, significantly outperforming traditional iterative or purely generative design methods in efficiency and programmability. The resulting metamaterial designs exhibit highly programmable and non-intuitive functional properties.

SUGGESTED USES

- Designing acoustic or electromagnetic cloaking devices that require specific, nonlinear wave manipulation.
- Engineering mechanical metamaterials with complex, programmable force-displacement curves for shock absorption or soft robotics.
- Developing smart materials and sensors that exhibit highly customized nonlinear response profiles to environmental stimuli (e.g., temperature, pressure).
- Creating optical components with tailored, nonlinear light-matter interaction for advanced imaging or computing.

ADVANTAGES

- Accelerated Design: Significantly reduces the time and computational resources required to design metamaterials compared to conventional methods.
- High Programmability: Enables the precise and reliable programming of multiple nonlinear functional responses based on a target physical response curve.
- Optimal Structure Generation: Utilizes MCTS to explore the design space effectively and select a graph representation of the metamaterial with the highest reward, ensuring an optimized structure.
- Hybrid Learning Efficiency: The combination of pretraining (imitation learning) and fine-tuning (reinforcement learning) enhances the policy network's ability to quickly converge on effective designs.

RELATED MATERIALS

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INVENTORS

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OTHER INFORMATION

CATEGORIZED AS

- **Computer**
  - Software
- **Engineering**
  - Engineering
- **Imaging**
  - 3D/Immersive
  - Other
- **Materials & Chemicals**
  - Composites
  - Nanomaterials
  - Other
- **Nanotechnology**
  - Materials
  - Other
- **Research Tools**
  - Other
  - Screening Assays
- **Sensors & Instrumentation**
  - Physical Measurement
  - Scientific/Research

RELATED CASES

2025-054-0

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Method To Inverse Design Mechanical Behaviors Using Artificial Intelligence

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