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PROCEEDINGS

Light Interacted Soft Units for Mechanical Logics

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ABSTRACT

Integrating mechanical computing capabilities into robotic materials or systems enhances their intelligence in stimulus-response processes. However, current mechanical computing systems face limitations such as incomplete functionality, inflexible computational rules, challenges in implementing sequential and random logic operations, and lack of reusability. To address these issues, we propose a straightforward design method based on logical expressions to achieve more complex computational tasks. We developed soft B-shaped mechanical metamaterial units and introduced stress inputs through compression. The outputs are represented by light-shielding effects caused by unit deformation. Using this approach, we successfully implemented logic gates and their combinations, such as half and full adders, half and full subtractors, and provided a streamlined solution for constructing a mechanical analog-to-digital converter (ADC) and a pseudo-random number generator. All computations occur within the elastic deformation range of the B-shaped units, allowing the system to revert to its initial state after each operation for reuse. By embedding these mechanical computing modules, robotic materials or systems can potentially execute complex tasks, such as delayed responses and multi-strategy. This design not only overcomes the limitations of existing mechanical computing systems but also opens new possibilities for future intelligent materials and technologies. Leveraging the unique properties of mechanical metamaterials, we demonstrate a reusable, multifunctional computing framework that lays the groundwork for advancing robotics and autonomous systems. This approach enhances system flexibility and adaptability while offering novel tools for automating intricate tasks.

KEYWORDS

Mechanical computation; soft material; robotic; deformation

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