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Case ID:M19-196P
Published: 4/8/2020

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Mechanical Metamaterials for Ultra-Low Frequency Vibration Isolation

Background

Vibration is one of the main causes of performance degradation of precision instruments, vibration noise, failure of structural parts, and human discomfort. In particular, the human body is most sensitive to vibrations in low frequency range especially for the wounded and newborn babies in transit. Thus, effective low-frequency vibration isolation can find numerous and varied applications. However, with traditional linear passive systems, a lower isolation frequency comes at the expense of static bearing capacity.

Invention Description

Researchers at Arizona State University have developed a mechanical metamaterial that can function as an absolute zero stiffness component for vibration isolation below 20 Hz, a frequency range that may cause harmful resonance with human organs. This is achieved by trapping the input energy inside the surrounding metamaterials without altering the state of the encased object. Isolation performance of the metamaterial can be adjusted in-situ according to the given payload. Further, this passive model can be used to prevent the failure of quasi-zero stiffness isolators for the low-frequency range or large amplitudes.

Potential Applications

- Vibration isolation for
  - Aerospace and structural engineering
  - Transportation
  - Medical instruments

Benefits and Advantages

- Traps mechanical energy inside metamaterial and shields encased object from input energy flux
- Fully passive system does not require active sensing or feedback

- Tunable to payloads by adjustment of spring constants and positions
- Prevents failure associated with quasi-zero stiffness isolators

Laboratory Homepage of Professor Hanqing Jiang