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Mondher Ouari, Matthieu Guédra, Anis Kaci, Frédéric Giraud, Christophe Giraud-Audine, et al.. Ultra shear force generation using locally resonant metamaterial. Eurohaptics 2024, Jul 2024, Lille, France. hal-04770798v2

HAL Id: hal-04770798

<https://hal.science/hal-04770798v2>

Submitted on 15 Nov 2024

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Ultra shear force generation using locally resonant metamaterial

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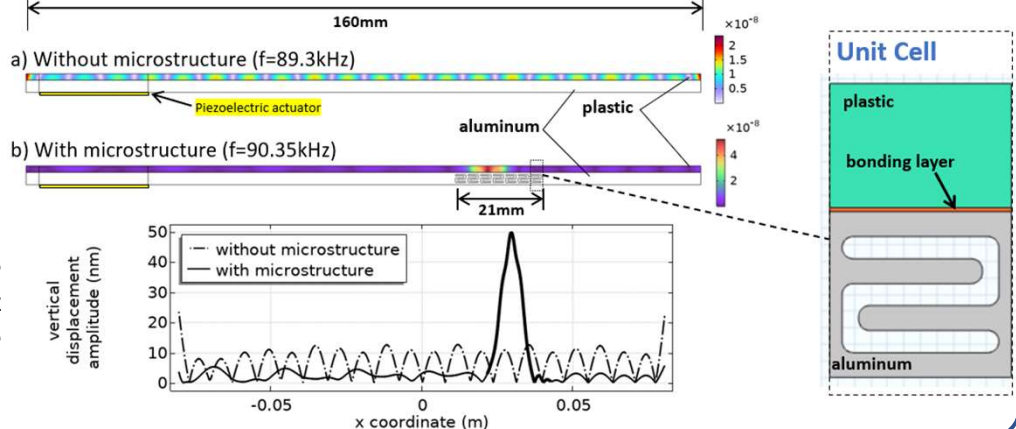
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Introduction

- Traditional haptic feedback produces unwanted noise and is incapable of conveying complex information.
- Solutions based on rapid friction changes from ultrasonic waves or using ultra shear forces have limitations, especially on large plates.
- Novel solution using locally resonant media, enabling matching of vibration modes on large plates for effective haptic feedback without noise.

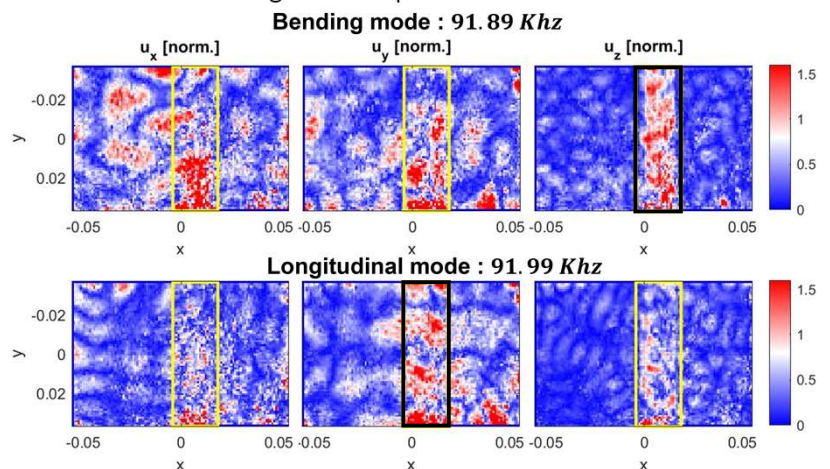
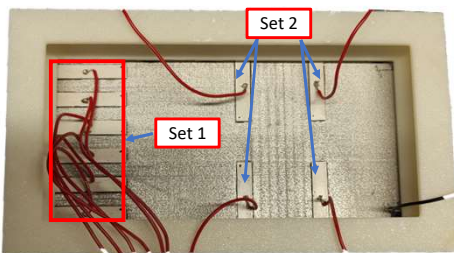
Locally resonant medium

- Prototype consists of a touchscreen bonded with an aluminum plate, actuated from the back face by piezoelectric element. The touchscreen is modelled as plastic layer that will mimic an OLED display with elastic damping.
- The locally resonant microstructure is made of several equally spaced unit cells embedded in the aluminum plate.
- Finite-element simulations reveal that the vertical vibration amplitude with metamaterials is nearly **five times** higher than the resonant bending mode amplitude without them.
- For the configuration with the microstructure, 90.35 kHz corresponds to a local resonance inside the metamaterial.



Experimental prototype

- For the prototype, we used an aluminum plate measuring 110×75 mm, with the same thickness as previous model. The microstructure is embedded within part of the plate.
- The selected dimensions enable the excitation of two localized modes using two independent sets of actuators:
 - Set 1 : actuate a bending mode
 - Set 2 : actuate a longitudinal mode
- The bending mode also causes in-plane vibrations, which may not be ideal for the application.



Conclusion/Perspectives

- A prototype capable of localizing two vibration modes, a bending mode, and a longitudinal mode, on the same zone of a large plate was developed.
- Further work is needed to control the phase shift and generate Ultra shear force.