MSc Internship (or equivalent)

Experimental and numerical study of sub-wavelength imaging based on Extraordinary Acoustic Transmission (EAT)

Keywords

Metamaterial, focusing, imaging, transducer, simulation, finite elements.

Context

To improve the spatial resolution of ultrasonic images, a solution is to increase the frequency to reduce the wavelength. In the frame of the ANR project BEAT (2022-2025), we are proposing to explore another solution: the subwavelength focusing of the acoustic energy to reduce the focal spot under the diffraction limit [1]. This solution is based on the concept of Extraordinary Acoustic Transmission (EAT) which allows to concentrate, within a subwavelength size spot, more acoustic energy than expected by geometrical considerations [2]. In the frame of this project, several prototypes for focusing elastic waves on a sub-wavelength scale have been already designed and developed.

Proposed work

The main objective of this internship is to test these prototypes in an "acoustic imaging" configuration. The main study points are as follows :

- Study of the temporal and frequency responses of the various prototypes ;
- Study of the influence of the distance between the object to be imaged and the prototype probe. Determination of phase, amplitude and frequency differences to obtain an abacus linking acoustic quantities to the position of the object .
- Mechanical scanning imaging.
- Production of 1D profiles and/or 2D images and determination of the resolution limits of the proposed sub-wavelength acoustic microscope.
- finite element simulations: use and adaptation of the numerical model developed as part of this project.

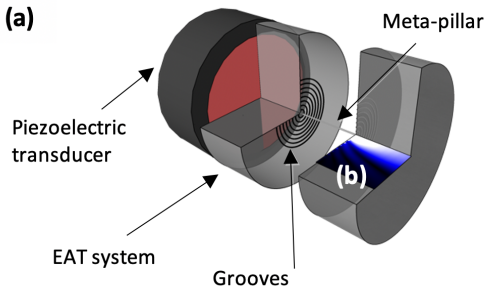

Fig1. Schematic diagram of the EAT device
(a) By coupling an ultrasonic transducer to an architecture made with a meta-pillar and grooves, **(b)** a focalization of the acoustic energy at a sub-wavelength scale is expected [2].

[1] A. A. Maznev, O. B. Wright, Upholding the diffraction limit in the focusing of light and sound, Wave Motion 68, 182–189 (2017).

GREMAN UMR 7347, Bât. E, Parc de Grandmont, 37200 Tours, France
Tel +33 (0)2 47 36 70 88 / greman@univ-tours.fr
www.greman.univ-tours.fr

[2] T. Devaux, H. Tozawa, P. H. Otsuka, S. Mezil, M. Tomoda, O. Matsuda, E. Bok, S. H. Lee, O. B. Wright, Giant extraordinary transmission of acoustic waves through a nanowire, Science Advances 6, 8507 (2020).

Candidate

Student in Engineering school / in Master or equivalent. Knowledges in ultrasonics are required. FEM or COMSOL skills will be appreciated.

Place

This internship will take place at the Laboratory GREMAN (UMR CNRS 7347) in Blois at INSA Centre Val de Loire. http://greman.univ-tours.fr/

Period and duration

Internship of 4-6 months from February/March 2025

Supervision and contact:

- Thibaut DEVAUX, Assistant Professor, Laboratory GREMAN, Tours University, thibaut.devaux@univ-tours.fr
- Lionel HAUMESSER, Assistant Professor (HDR), Laboratory GREMAN, Tours University, lionel.haumesser@univ-tours.fr