

PhD proposal (2026-2029): concours doctoral grant

Theoretical and experimental investigation of aero-acoustics in time-varying deformable waveguides: application to speech sound production

Context and state of the art

Within the context of human speech productions, waveguide acoustics is well studied for steady geometries and in absence of flow. Nevertheless, human speech sound production involves articulation and respiratory airflow, which are omitted from most studies dealing with the physics of speech production. As such, the originality of the proposed PhD is two-fold in addressing firstly the influence of time-varying waveguide properties (area, cross-section shapes, elasticity) on acoustic wave propagation and secondly in accounting for wave propagation and generation in presence of airflow. This last aspect implies to address the influence of waveguide dynamics on the generation and interaction of different sound sources – e.g., due to a fluid-structure interaction for voiced sounds or of aero-acoustic nature for fricatives – as well as the influence of waveguide's wall properties on sound propagation and interaction.

Objectives

This PhD focuses on a systematic theoretical and experimental investigation of aeroacoustic phenomena in time-varying rigid and deformable waveguides under conditions (elasticity, area, cross-section shape, flow, forcing) pertinent to human speech sound production.

Thus, the influence of time-varying waveguides on both wave propagation, sound source mechanisms (fluid-structure interaction or aero-acoustics) and sound source interactions (co-existence, coupling, etc) is aimed for. Besides for characterization, the gathered experimental data are needed to establish and validate quasi-analytical models of sound production and propagation.

Methodology

The proposed methodology relies on exploiting the recently established framework which considers the use of squeezed deformable waveguides to study wave propagation pertinent for sustained vowels (Eliraki et al., J Acoust Soc Am, 2026). It is aimed to expand this framework to wave propagation to time-varying waveguides pertinent for concatenated vowel configurations firstly without and secondly with airflow. It is noted that the experimental setup used to validate the framework for steady waveguide configurations is suitable to characterize and validate wave propagation through time-varying waveguides without and with flow. Temporal characteristics of waveguide deformation are taken from dynamic MRI data recently described in literature. At first the frequency range up to 4 kHz is considered as higher order acoustic mode propagation can be neglected for vowel sound production. In a second stage, as aero-acoustic sound source generation is studied the frequency range will be extended to 10 kHz. It is aimed to confront quasi-analytical model of sound generation and propagation with gathered experimental data.

Expected results

Results will be published in relevant journals, presented at conferences and developed in the thesis manuscript.

Supervision, location and contact

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- Annemie Van Hirtum (DR CNRS, annemie.vanhirtum@univ-grenoble-alpes.fr)

The PhD will be carried out at LEGI (Grenoble Campus, France) with regular visits to LPP (Paris, France).

Application: online before 10/5/2026

Highly motivated students with a degree (5-year master or engineering degree obtained or to be obtained in the academic year 2026-2027) in fluid mechanics, (aero)acoustics, physics or applied mathematics can apply online:

https://adum.fr/as/ed/voirproposition.pl?langue=&site=edimep2&matricule_prop=70303

Additional information (see contacts).

Websites

<http://www.legi.grenoble-inp.fr/people/annemie.van-hirtum/>