PhD position within ANR project Full3DTalkingHead at LEGI, Grenoble

Aero-acoustic study of the influence of waveguide dynamics on sound production, propagation and radiation for human speech

Introduction and objective

The PhD position is funded within the ANR project Full3DTalkingHead, titled "Fully 3D talking head with aero-acoustic simulations", which aims to study dynamic speech sound production. As such, the PhD candidate benefits from an interdisciplinary consortium gathering experts in medical imaging, phonetics, data sciences and aero-acoustics.

The physics of human speech sound production presents itself as a complex fluid-structure-acoustic interaction problem. The generation of a single phoneme can be described as a sound source, origination somewhere in the upper airways i.e. the glottis and vocal tract, the sound then propagates through the vocal tract waveguide and is subsequently radiated at the lips. Whereas the physical phenomena underlying single phoneme speech sound production are well known, the dynamic nature of speech sound production is less studied.

Therefore, the aim of this PhD is to contribute to the understanding, modelling and simulation of 3D waveguide dynamics on the sound sources and subsequent sound propagation and radiation.

Methods

A systematic study of the influence of waveguide dynamics is assessed combining experimental, numerical and theoretical work for simplified parameterised upper airways. Simplified parameterised upper airways are preferred in order to control the waveguide geometries at all deformation stages while grasping main articulatory characteristics of the vocal tract.

From an **experimental point of view**, it is foreseen to develop and improve the existing prototype [1] of the upper airway replica shown in Fig. 1 and to perform dynamic aero-acoustic measurements of the pertinent physical flow and acoustic variables. It is sought to assess to which extent the simplified waveguides limit the range of sound sources, sound source interaction and subsequent sound propagation and radiation in terms of phonemes as well as spectral range. In addition, it is aimed to explore the mutual relationship between waveguide control parameters and measured flow and acoustic variables using a smart data science approach resulting from the combination of a physical model approach with a data analysis approach.

Concerning the **physical model approach**, it is aimed to propose experimentally validated theoretical models of the flow and acoustic fields leading to sound sources, their interaction and subsequent sound propagation and radiation. As within this PhD the focus lies on dynamic waveguides particular attention is given to the generation and the extension of sound sources and the influence of the dynamics on a quasi-steady approach. A triple validation between theoretical models, numerical simulation and model results is aimed. As the Full3DTalkingHead project includes data sciences approaches, physical modelling exploiting statistical laws relying on theoretical model results are expected.

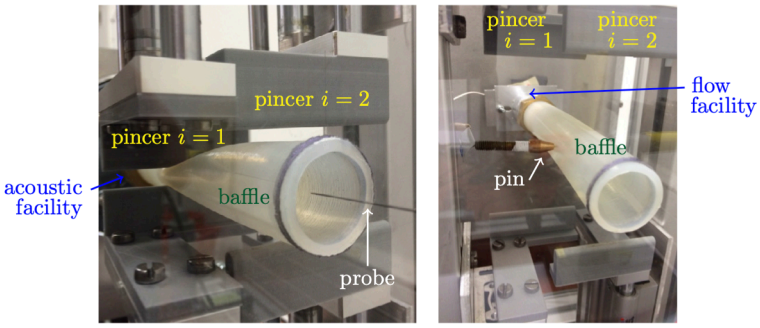

Fig. 1. Prototype of upper airway replica with a simplified time-varying waveguide set in a baffle. Both acoustic (left) as flow (right) fields are studied.

References

[1] Van Hirtum A., Blandin R., Pelorson X., 2016. A setup to study aero-acoustics for finite length ducts with time-varying shape. Applied Acoustics, 105:83-92.

see also at http://www.legi.grenoble-inp.fr/people/annemie.van-hirtum/

Application

Physics, Applied mathematics, Acoustics, Data science and signal processing, Mechanics

A strong interest and basic skills with respect to both numerical/theoretical and experiments is advised.

Send a CV and motivation letter to:
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