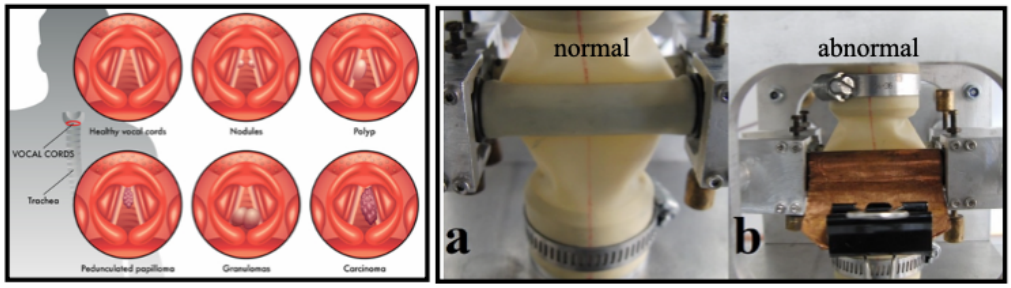
Experimental and theoretical study of the influence of structural properties on the fluid-structure interaction underlying the human voice without and with pathology

Introduction and objectives.

The human voice (vowel sounds) is due to an auto-oscillation of the vocal folds. This auto-oscillation is the result of a fluid-structure interaction between the airflow coming from the lungs and the deformable structure of the vocal folds. Consequently, structural properties influence the voice outcome under normal as well as under pathological conditions (see left frame of Fig. 1).

The objective of this internship is to contribute to a physical study of the influence of local and/or global structural changes to the vocal folds structure on 1) the ongoing fluid-structure interaction and 2) on the resulting auto-oscillation. This internship is part of an ongoing PhD. Depending on the profile and competences of the candidate, the focus is on the experimental or modeling aspect. Both aspects are briefly outlined below.



human vocal folds pathologies — mechanical vocal fold replica

Fig. 1 Illustration of deformable vocal folds. Left frame: schematic observations of structural pathologies on human vocal folds [1]. Right frame: mechanical vocal fold replica without (a) and with (b) structural changes mimicking a scarred vocal fold [2].

Modeling aspect.

The aimed modeling is two-fold. Firstly, it is aimed to model the influence of structural changes mimicking the vocal folds with and without pathology on the mechanical properties of the structure expressed by its resonances and elasticity. Secondly, it is aimed to integrate this model in a physical model of the fluid-structure interaction and to characterize and quantify the influence on the model outcome related to the flow behavior and to the auto-oscillation characteristics.

Experimental aspect.

The experimental study relies on mechanical vocal folds replicas suitable for physical studies. The ongoing fluid-structure interaction can be studied experimentally by placing vocal folds replicas in an experimental setup allowing to control pertinent physical quantities. Mechanical properties are characterized by considering frequency response functions and load tests. It is aimed to systematically vary properties of mechanical vocal folds replicas (see right frame of Fig. 1).

References.

[1] taken from http://ent.uci.edu/more-at-uc-irvine/more-on-throat-disorders/vocal-cord-nodule.asp

[2] M. Ahmad, 2019. Experimental study of the threshold of oscillation of a scarred vocal fold replica. Master thesis, Univ. Grenoble Alpes, pp.48.

Location and contact.

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Competences required.

Engineering/master student with strong interest in research in the fields of mechanics (structural and fluid). Experimental skills are appreciated.