Internship position at LEGI, Grenoble Campus

Influence of structural properties of mechanical vocal folds replicas on their auto-oscillation

Pertinent fields: physics/mechanics/aero-acoustics, signal processing and instrumentation

Introduction and objective

The auto-oscillation of the vocal folds is the main sound source associated with human voiced sound production, e.g. vowels. This auto-oscillation results from 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 abnormal or pathological conditions. The structure of a normal vocal fold is often represented as consisting of overlapping layers as depicted in the right frame of Fig 1. The different layers have different elasticity and dimensions. Structural abnormalities are then often associated with local stiffening as shown in the left frame of Fig. 1.

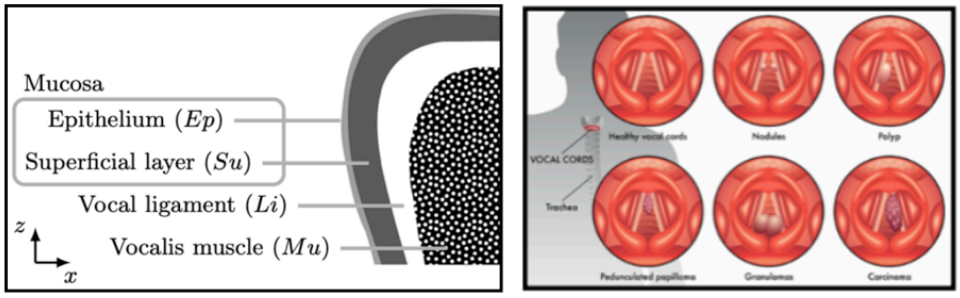

Fig. 1: Left: illustration of human vocal folds and structural abnormalities/pathologies [1]. Right: multi-layer representation of vocal fold structure [2].

*The **overall objective** of this internship is to contribute to the physical and systematic study of the influence of local and/or global structural changes to the vocal folds structure on 1) the mechanical properties, 2) the ongoing fluid-structure interaction and 3) the resulting auto-oscillation and sound source.*

In all cases, the internship comprises an important experimental component as it needed to reproduce the phenomena under controlled conditions, to perform a quantitative characterisation from which model validation can be assessed. Depending on the profile, competences and level of the candidate, the focus of the internship is adapted. In the following the experimental aspects of the methodology are outlined.

Methodology

The experimental physical study relies on mechanical vocal folds replicas for which the mechanical behaviour can be characterised. Two types of mechanical vocal folds replicas are illustrated in Fig.

2. It is aimed to adapt these replicas so that abnormal structural conditions (as illustrated in Fig.2) can be systematically reproduced. A first series of systematic measurements is then performed aim-

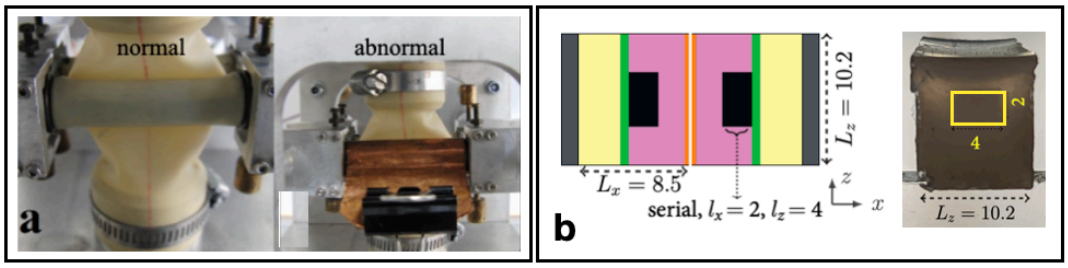

Fig. 2: Illustration of two types of mechanical vocal fold replicas with a structural abnormality: a) surface stiffening and b) stiff inclusion.

ing to quantify the potential impact of these changes on the structural properties.

A second series of measurements is obtained when developed replicas are placed in a setup developed to study the fluid-structure interaction and their subsequent auto-oscillation for controlled conditions.

Experimental results of these systematic studies are thus firstly used to characterize mechanical, flow and structure phenomena. Next, assessed experimental data are used for the validation of theoretical models of firstly the mechanical properties and secondly of the fluid-structure interaction.

References

[1] M. Ahmad, 2019. Experimental study of the threshold of oscillation of a scarred vocal fold replica. Master thesis, Univ. Grenoble Alpes, pp.48.
[2] taken from http://ent.uci.edu/more-at-uc-irvine/more-on-throat-disorders/vocal-cord- nodule.asp
[3] M. Ahmad, 2023. Study of the influence of structural properties on the fluid-structure interaction of artificial vocal folds. PhD thesis, Univ. Grenoble Alpes, pp.160.

Location, how-to-apply and contact

LEGI, Grenoble University Campus: http://www.legi.grenoble-inp.fr
Send a CV and motivation letter to:
annemie.vanhirtum@univ-grenoble-alpes.fr
xavier.pelorson@univ-grenoble-alpes.fr

Competences required

Engineering/master student with strong interest in one or all of the following fields: mechanics(material and/or fluid)/physics/aero-acoustics, signal processing and instrumentation, theoretical modeling. Experimental skills are appreciated.