Chair of Vibroacoustics of Vehicles and Machines
TUM School of Engineering and Design
Technical University of Munich

Bachelor Thesis | **Semester Thesis** | **Experimental**

Optimized Acoustic Property Based on Simplified Equivalent-Fluid Model

Background

Porous materials are widely used for sound absorption and noise control in engineering applications. Their acoustic behaviour is often described using *equivalent-fluid models*, which treat the solid frame as motionless and model sound propagation through the air contained within the pore space. Such models provide a good balance between physical accuracy and computational efficiency and are therefore commonly used in both research and engineering design. Equivalent-fluid models rely on a set of non-acoustical material parameters, such as porosity, airflow resistivity, tortuosity, and characteristic lengths. However, most of these parameters are difficult to measure directly and are typically identified indirectly from acoustic measurements. This indirect identification introduces uncertainty and limits the applicability of the models for material optimisation. Recent research has demonstrated that the complexity of equivalent-fluid models can be significantly reduced using experiment-driven simplification strategies. In particular, it has been shown that key acoustic properties of porous materials can be described primarily as functions of open porosity. This reduction enables robust acoustic optimisation while retaining the essential physical behaviour of porous sound absorbers.

Objectives

The objective of this semester thesis is to apply and validate a simplified equivalent-fluid modelling framework for porous materials and to use it for acoustic optimisation based on experimental data.

- Apply an equivalent-fluid model to describe sound propagation in porous materials.
- Quantify uncertainty in indirectly identified material parameters using Bayesian inference.
- Optimise acoustic performance, such as sound absorption, under practical constraints.

Your Tasks

- Study the fundamentals of sound propagation in porous materials using equivalent-fluid theory.
- Perform impedance tube measurements on porous samples using the two-microphone method.
- Implement Bayesian inference to estimate non-acoustical parameters from measurement data.
- Apply regression techniques to link inferred parameters to open porosity.
- Develop an optimisation strategy to tune material parameters for improved sound absorption.

Requirements

- Interest in acoustics and porous materials.
- Basic proficiency in MATLAB or Python for data analysis.
- Willingness to conduct laboratory measurements with an impedance tube.
- Ability to work independently on an experimentally and numerically oriented topic.

Contact

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