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

**Semester Thesis | Master's Thesis**

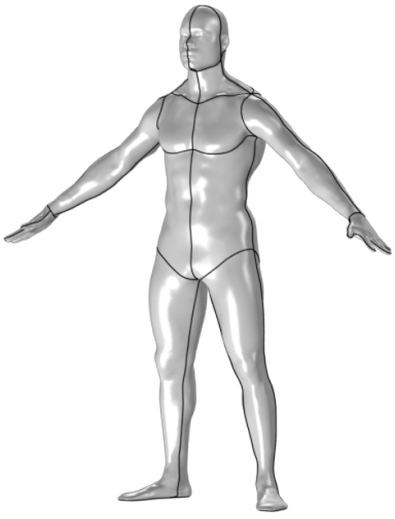
# Acoustic characterization of human skin using probabilistic methods

## Problem description

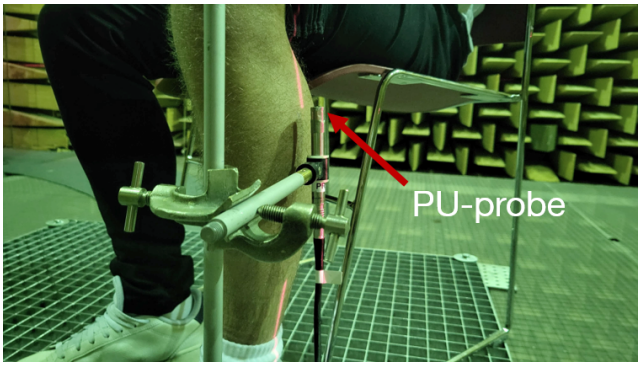
In acoustic simulation models such as Head-Related Transfer Function (HRTF) computations, human skin is often modeled as a sound-hard surface. However, this assumption fails in the mid to high-frequency ranges where the skin exhibits partial reflectivity. Accurate characterization of the skin's acoustic properties is challenging due to the limitations of direct measurement methods. Specifically, while the specific acoustic impedance can be measured close to the surface using a PU-probe, direct measurement of the acoustic surface impedance remains infeasible. This thesis aims to estimate the normal surface impedance of human skin by reconstructing the acoustic field quantities on the surface using Near-Field Acoustic Holography (NAH). NAH faces challenges, particularly in the presence of noise, as it is necessary to solve an ill-posed inverse problem for the reconstruction. To address these challenges, a probabilistic Bayesian approach is employed, which offers advantages in the presence of noise and enables quantifying the associated uncertainty of the estimation, thereby improving the fidelity of acoustic simulations involving human skin.

## Tasks

- Implementation of NAH to reconstruct acoustic quantities on the surface.
- Implementation of Bayesian inference framework for the probabilistic solution of the inverse reconstruction problem.
- Test the surface impedance estimation framework with numerically generated acoustic field data and known surface impedance values and added noise.
- Use measurement PU-probe data of a material of known properties and compare it to the estimation results.
- Use existing human skin measurement data and estimate the surface impedance with corresponding uncertainty.



Acoustic simulation model of a human body.




Simultaneous measurement of sound pressure and particle velocity with a PU-probe near human skin.

## Contact

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