Modeling of a hearing aid receiver

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Introduction

A hearing aid receiver is a tiny loudspeaker. Efforts are made to miniaturize these components even further. Standard acoustic methods cannot be used to describe the behavior of air inside these receivers due to the manifestation of viscothermal effects.

Objective

The objective of current research is:

- Improving receiver models

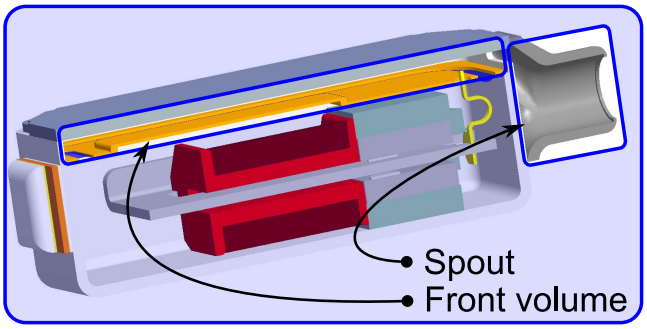

Figure 1 : Cross section of a hearing aid receiver

Receiver models

Current receiver models are based on a lumped electrical analogue. These models describe volumes and tubes very well. However, the underlying theory cannot describe the receiver completely.

Three dimensional sound propagation including viscothermal effects is described by the linearized Navier-Stokes equations. These equations are rather hard to solve. Nevertheless, parts of the receiver like the spout (Figure 1) may need to be modeled with these equations. The derivation of a FEM-formulation of the linearized Navier stokes equations will be a part of this research.

The receiver contains some layer parts, e.g. the front volume (Figure 1), in which propagation is virtually 2D. The low reduced frequency (LRF) model is an accurate and efficient model for layers under certain circumstances. FEM-formulations of the low reduced frequency model exist and semi-analytical formulations based on the Trefftz approach are being researched.

Results

The front volume (Figure 1) could be modeled as a rectangular layer. A circular layer however, can be found in another device made by Sonion, the company that finances this PhD-research. Figure 2 shows a schematic drawing of the involved structure. The circular layer is located between the fixed surface and the rigidly and harmonically translating plate. Air can enter and leave the layer at the outer circumference, however not at the barriers. The low reduced frequency model has been used to calculate the pressure profile for a certain frequency (Figure 2). The required force and resulting volume flow can be easily calculated from the solution [1]. A more extensive model of this layer is currently being integrated into the existing receiver model.

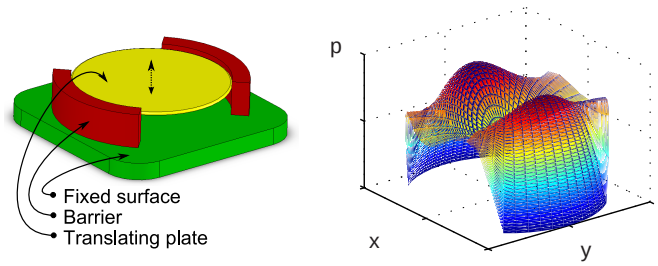

Figure 2 : layer geometry and calculated pressure profile

Future research

Further research will be focussed on:

- Application and experimental validation of the LRF-model for various layers
- Derivation of a FEM-formulation for the linearized Navier-Stokes equations

Reference

1. Kampinga, W.R., Y.H. Wijnant, A. De Boer (2006) Viscothermal wave propagation in a circular layer with a partially open and partially closed boundary, ISMA, Leuven, Belgium.