Numerical Acoustics – Spring 2025

Exercise 11: Numerical models of condenser microphones

This exercise deals with the application of BEM and FEM with viscous and thermal losses to the modeling of condenser measurement microphones.

BEM with viscous and thermal losses

A compressed file with the necessary Matlab functions and scripts has been uploaded. It includes some pre-calculated coefficient matrices to save time. This is research software and the results have been used in different publications. Two of them are included in the package.

The code contains two examples located in the *ViscoThermal* folder:

A. An idealized simple microphone geometry with only a gap and no back cavity (file *VT_IdealMIC_SolveSystem*).
B. A model of the Brüel&Kjær type 4938/4939 condenser measurement microphone (file *BK4938_BK4939_AxiBEMmodel*). It includes both interior and exterior domains.

The simple microphone has an analytical solution to compare with. The implementations are finished. Items to observe in the two examples:

1. The coupled system of equations (lines 124 in A and 205 in B): in the B&K 4938/4939, the exterior domain is included in the coupling. Identify the items in the coupled coefficient matrix. Use the lecture slide showing the coupled system as a reference.
2. The B&K 4938/4939 uses an independent mesh for the diaphragm, which is coupled to interior and exterior domains. Observe how the coupling is made (lines 101 to 138).
3. The diaphragms of the microphones are modeled using one-dimensional FEM (files *FEMmemLIN* and *FEMmemQUAD*, lines 65 in A and 81 in B). Open these files and examine the FEM implementation, considering what you have learned about FEM.
4. At Line 12 of file B you may change the microphone to either a B&K 4938 or a B&K 4939. One of them is a pressure microphone and the other a free-field microphone. Find out what is actually changed. The simulation corresponds to the actual devices.
5. You may also change the excitation from a uniform pressure (actuator) to an incoming plane wave (line 9). Follow the code to see how this is done in the coupled system of equations within the frequency loop.

Vicente Cutanda Henriquez - 3-2025