Prediction of the vibroacoustic behavior of a human head coupled with an earplug using the finite element method

A 48 months competitive Ph.D. funding (19000$ annual) is offered by IRSST. The Ph.D. candidate submits an application to IRSST with his supervisor by the third Wednesday of October 2016. The evaluation results are given in April 2017 (start date of the Ph.D. if the grant is obtained). The Ph.D. candidate must be a Canadian citizen or permanent resident. He(she) will be registered at École de Technologie Supérieure de Montréal and will do his(her) Ph.D. at ICAR laboratory (http://icar.etsmtl.ca/). He(she) will be cosupervised by Dr Franck Sgard (IRSST) and Pr Éric Wagnac (ÉTS).

Topic

One of the reasons for which hearing protectors devices (HPD) are not completely efficient at protecting from noisy environments is because of the auditory discomfort they induce. This discomfort may lead the individual to not wear his HPD correctly or remove it. The auditory discomfort is influenced by the value of the sound pressure in the ear canal. To reduce it efficiently, a numerical finite element model of a human head including the full hearing system and the cranium allowing for simulating the propagation of elasto-acoustic waves created by a noisy environment or a mechanical source and assessing this ear canal sound pressure is needed. The objective of this Ph.D. is to develop, validate and exploit a numerical vibroacoustic model (VM) of a human head coupled with a custom earplug with known physical properties. The candidate will start from a realistic 3D geometrical model of a human head obtained from medical images that has been developed in the scope of a master thesis. The head/earplug system VM will be validated and calibrated step by step by creating experimental anatomical fantoms of increasing complexity that will be manufactured using representative average synthetic biomaterials with the help of a specialized company. The validation will be carried out by comparing the simulation results and measurement data on the open and occluded ear for acoustic and mechanical excitation. The VM will then be calibrated with respect to the human subject whose head has been scanned. Finally, this VM will be exploited via a sensitivity analysis in order to study the sound transmission mechanisms through the head/earplug system.

Candidate profile

This project includeds both modeling and experimental aspects. The candidate must detain a master in mechanical engineering or in physics. He must have a background in acoustics, design, measurement and know the finite element method.

Contact : Franck Sgard (Franck.Sgard@irsst.qc.ca)

Deadline: September 1, 2016