Investigating hearing biomechanics using a physiologically-based computational model

Julien Meaud
Department of Mechanical Engineering

Joint Mechanical and Biomedical Engineering Seminar
11AM Friday October 16, 2015
614 Schermerhorn

The mammalian ear is able to sense faint sounds (down to 20 μPa), distinguish between close frequencies (less than 0.1% apart) and operate over a broad range of sound intensities (6 orders of magnitude). These striking functional characteristics are due to the presence of an active feedback mechanism linked to outer hair cell activity in the sensory organ of the inner ear, the cochlea. Failure of the cochlear amplifier due to genetic disorders, ototoxic drugs, sound overexposure or aging causes deafness or hearing loss. Better understanding of how the cochlea processes sounds is needed to better protect hearing, diagnose hearing pathologies and treat hearing loss. In this talk, I will present a multi-physics computational model of the mammalian ear that couples a middle ear model to a finite element model of the cochlea. I will demonstrate that this physically-motivated model is able to simulate the main aspects of the nonlinear response of the cochlea to sounds and can be used to test key hypotheses about cochlear function. Three main questions linked to experimental observations and with both fundamental and clinical implications will be the focus of this presentation: (1) what is the main cellular mechanism that underlies cochlear amplification? (2) How does direct mechanical coupling between each cross-section of the cochlear partition affect cochlear function? (3) How do sounds generated by the cochlea propagate to the ear canal?