A Fluid Particle Simulation to Study the Motion Sickness in Semicircular Canal

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Abstract

The vestibular systems are very important to balance of body. But some people have vertigo and dizziness caused by vestibular disorder. It is well known how the symptom appears physiologically. The benign paroxysmal positional vertigo (BPPV) which comes from moving an otolith in endolymph is called as motion sickness. Through the simulation, we can better understand the symptom when there are many otoliths in the canal. It is enhanced to rehabilitation therapy. In the view of numerical simulation, fluid structural interaction problem is difficult to get a results with a lot of changed mesh needed. So particle tracing method is suitable for this case.

In this study, to simulate motion sickness, the features offered from the Particle Tracing Module in COMSOL Multiphysics® are used to analyze internal physical phenomenon and evaluate vestibular system at various conditions. In the Particle Tracing Module, the Particle Tracing for Fluid Flow interface is used to study motion and mass of otolith in the background fluid, the Laminar Flow interface is used to study endolymph that is background flow. The used physics interfaces are coupled with each other, and physical phenomena are simulated for particle motion driven by drag and gravity. The model is validated from reference paper, and extended to calculate as various conditions.

Reference

[1] C.F. Santos, J.B. Belinha, F.G. Gentil, M. Parente, R.N. Jorge, An alternative 3D numerical method to study the biomechanical behavior of the human inner ear semicircular canal, Acta Bioeng Biomech. Vol.19(1), p3-15 (2017)

[2] M. Kassemi, D. Deserranno, J.G. Oas, “Fluid-structural interactions in the inner ear”, Computers and Structures, Vol. 83, p.181-189, (2005)

Figures used in the abstract

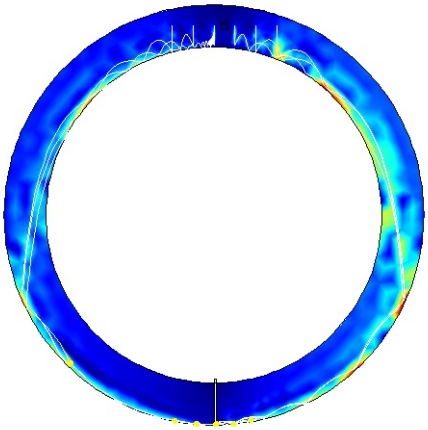

Figure 1: The motion of otoliths (yellow color) and velocity field of endolymph in simple geometry.