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Three-dimensional modal analysis of an idealized human head including fluid-structure interaction effects. (English) Zbl 1356.74052

Acta Mech. 223, No. 9, 1899-1915 (2012).

Summary: A three-dimensional analytical and numerical method is presented in this article for the analysis of the acoustic fluid-structure interaction systems including, but not limited to, the brain, cerebro-spinal fluid (CSF), and skull. The model considers a three-dimensional acoustic fluid medium interacting with two solid domains. This article deals with the analytical and numerical computation of eigenproperties for an idealized human head model including fluid-structure interaction phenomena. We determine in the present work the natural frequencies and the modes shapes of the system of the brain, cerebro-spinal fluid (CSF), and skull. Two models are presented in this study: an elastic skull model and a rigid model. In the analysis, a potential technique is used to obtain in three-dimensional cylindrical coordinates a general solution for a solid problem. A finite element method analysis is also used to check the validity of the present method. The results from the proposed method are in good agreement with numerical solutions. The effects of the fluid thickness and compressibility on the natural frequencies are also investigated.

MSC:

74F10 Fluid-solid interactions (including aero- and hydro-elasticity, porosity, etc.)
74L15 Biomechanical solid mechanics
76Z99 Biological fluid mechanics
92C99 Physiological, cellular and medical topics

Full Text: DOI

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