Design+Analysis
VISITING LECTURE

"Elastodynamic Transformation Cloaking"

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Tuesday the 9th of July 2019 at 2 pm
Lecture hall R266, Rakentajanaukio 4 A, Otaniemi, Espoo

Visitor. Professor Yavari joined the School of Civil and Environmental Engineering at the Georgia Institute of Technology in January 2005. He received his B.S. in Civil Engineering from Sharif University of Technology, Tehran, Iran in 1997. He continued his studies at The George Washington University where he obtained an M.S. in Mechanical Engineering in 2000. He then moved to Pasadena, CA, and obtained his Ph.D. in Mechanical Engineering (Applied Mechanics option with minor in Mathematics) from the California Institute of Technology in 2005. Professor Yavari is a Fellow of the Society of Engineering Science and a member of the American Academy of Mechanics.

Abstract. We formulate the problems of nonlinear and linear elastodynamic transformation cloaking in a geometric framework. In particular, it is noted that a cloaking transformation is neither a spatial nor a referential change of frame (coordinates); a cloaking transformation maps the boundary-value problem of an isotropic and homogeneous elastic body (virtual problem) to that of an anisotropic and inhomogeneous elastic body with a hole surrounded by a cloak that is to be designed (physical problem). The virtual body has a desired mechanical response while the physical body is designed to mimic the same response outside the cloak using a cloaking transformation.

We show that nonlinear elastodynamic transformation cloaking is not possible while nonlinear elastostatic transformation cloaking may be possible for special deformations, e.g., radial deformations in a body with either a cylindrical or a spherical cavity. In the case of classical linear elastodynamics, in agreement with the previous observations in the literature, we show that the elastic constants in the cloak are not fully symmetric; they do not possess the minor symmetries. We prove that elastodynamic transformation cloaking is not possible regardless of the shape of the hole and the cloak. It is shown that the small-on-large theory, i.e., linearized elasticity with respect to a prestressed configuration, does not allow for transformation cloaking either. However, elastodynamic cloaking of a cylindrical hole is possible for in-plane deformations while it is not possible for anti-plane deformations.

We next show that for a cavity of any shape elastodynamic transformation cloaking cannot be achieved for linear gradient elastic solids; similar to classical linear elasticity the balance of angular momentum is the obstruction to transformation cloaking. We finally prove that transformation cloaking is not possible for linear elastic generalized Cosserat solids in dimension two for any shape of the hole and the cloak. In particular, in dimension two transformation cloaking cannot be achieved in linear Cosserat elasticity. We show that transformation cloaking for a spherical cavity covered by a spherical cloak is not possible in the setting of linear elastic generalized Cosserat elasticity. We conjecture that this result is true for a cavity of any shape.

We wish you welcome – coffee at 2 pm sharp, the presentation a quarter after the first dose!

Assistant Professor Jarkko Niiranen and Professor Emeritus Juha Paavola
Department of Civil Engineering, School of Engineering, Aalto University

Design+Analysis VISITING LECTURES target for presenting and discussing a diverse collection of topics related to C*omputational Structural Engineering* and *Structural Mechanics* from the perspective of *Structural Analysis* and in the context of *Architectural, Industrial and Structural Design,* with a special emphasis on *Theoretical and Applied Mechanics of Solids and Structures.* Accordingly, term *design* – besides architectural, industrial and structural design – refers to designing models and methods, whereas term *analysis* – besides structural analysis – refers to analyzing models and methods.