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Numerical solver for the modelling of guided waves propagation under stress condition in the context of SHM applications.

André Dalmora^{1,2,3}, Alexandre Imperiale¹, Sébastien Imperiale^{2,3}, Philippe Moireau^{2,3}

¹ Université Paris-Saclay, CEA, List, F-91120, Palaiseau, France

² Inria, Project-Team M Ξ DISIM, Inria Saclay-Île-de-France, 91128 Palaiseau, France

³ LMS, Ecole Polytechnique, CNRS, Institut Polytechnique de Paris, 91128 Palaiseau, France

In leading-edge industrial applications, assessing structure integrity is an important aspect of safety requirements. Structural Health Monitoring (SHM) proposes to use sensors and signal processing units in situ. One of the most attractive SHM techniques is ultrasonic guided waves. Guided waves propagate on large distances and interact with defects in the structure making damage detection possible. Modelling and simulation can be helpful tools for the design or the reliability assessment of SHM solutions. The currently available models developed for that purpose do not take into account the effect of operational conditions such as internal stresses. These conditions can modify wave propagation and therefore affect the interpretation of recorded signals.

The objective of this work is to propose a model and associated numerical methods for elastic wave propagation in an arbitrarily deformed medium. Any hyperelastic constitutive law can be considered. As the structures considered are usually thin, we avoid shear-locking by using a shell formulation to solve the quasi-static problem representing the effects of structure loading. The computed displacement is then fed into a spectral elements method (SEM) kernel to solve the time-domain linearized 3D elastodynamics problem representing the wave propagation. We validate our model for an isotropic aluminium plate under tensile forces. Additionally to the direct modelling, we aim at using these tools within inversion loops to reconstruct the prestresses by means of ultrasonic transducers measurements.
