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Imaging of Femur Neck Cortical Bone with Iterative Adjoint strategy

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Osteoporosis is a frequent bone disease that mainly affects women after menopause. It is characterized by a decrease in bone mass and a deterioration of the micro-architecture, therefore resulting in an increased risk of fracture. Ultrasound technologies provide an affordable mean to implement non invasive solutions, in order diagnostically assess the characteristics of the bone structure.
In this work, we are interested in 1) imaging the external and internal boundaries and 2) evaluating the thickness of the cortical bone. These two properties are important to interpret the measurements of guided waves dispersion curves and predict the risk of osteoporosis and fracture. However, it is difficult to image the cross-section of the bone with traditional ultrasonic techniques. Due to the recent developments of numerical simulation technology, the adjoint strategy, based on a simulated domain of propagation, has been widely used in geophysics tomography. In this work, we adapt this method to the imaging of the cortical bone.
The iterative procedure of the adjoint method provides better performance in imaging of the internal boundary of the cortical bone, compared to the one-step adjoint method. The main difficulty of implementing iterative adjoint method is the requirements of huge storage. We have implemented a back-propagation strategy to deal with this issue. Numerical simulations show the efficiency of this kind of numerical approach, and lead to promising results.