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COASTAL ENGINEERING APPLICATIONS OF CUTFEM FOR FLUID-STRUCTURE INTERACTION

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Understanding the effects of sea level rise on coastal ecosystems involves complex solid materials, such as mixed sediments and vegetation. Physical flume and basin studies have long been used in coastal engineering to understand wave and current dynamics around such structures. Numerical flumes based on computational fluid dynamics and fluid-structure interaction have recently begun to augment physical models for design studies, particularly for engineered structures where established Arbitrary Lagrangian-Eulerian (ALE) methods based on boundary-conforming meshes and isoparametric or isogeoemtric finite element methods are effective. The rapid growth of lidar and photogrammetry techniques at large scales and computed tomography at small scales has introduced the possibility of constructing numerical experiments for the complex natural materials in coastal ecosystems. These methods tend to produce low-order geometric representations with uneven resolution, which are typically not appropriate for conforming mesh generation. To address this challenge, recent work [1] extended an existing ALE method to include embedded solid dynamics using a piecewise linear CutFEM approach [2]. The implementation is based on equivalent polynomials [3]. The approach retains the convergence properties of the CutFEM method while having a simple implementation within the existing two-phase RANS model, which has been used frequently for numerical flume studies. This presentation will consider application and performance of the method for two critical coastal processes: wave interaction with vegetation and sediment dynamics.

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