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Modeling Fluid-Elastic Interaction in 3-D with First-Order System Least Squares (FOSLS)

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The mechanical interaction between a fluid and solid can me mathematically modeled using a number of different approaches depending on the physical characteristics of the problem being solved. We are interested in systems consisting of a Newtonian fluid, modeled using the Navier-Stokes equations, and a linear elastic material with properties similar to a soft tissue. These coupled fluid-elastic problems are inherently nonlinear because the shape of the fluid domain is not known a priori, and the computational grid must be moved or mapped. We typically use elliptic grid generation (EGG) to map the physical domain to a fixed computational domain. A FOSLS formulation of the Navier-Stokes, EGG, and linear elasticity equations provides a number of benefits to solving coupled systems problems, including: optimal finite element approximation in a desirable norm (H^1), $optimal multilevel solver performance, optimal scalability, and a sharp a posteriori error mea$
$D for a variety of problems, including the fully coupled fluid-elastic system. However, as expected, the extens$
$D brings new challenges for both the whole and the individual parts of the coupled system. Some of the issues asso$
$D have been partially or fully addressed, such as : growing complexity in the multilevel solver, iteration schem$
$refinement.$