Shape optimization of a coupled thermal fluid-structure problem in a level set mesh evolution framework

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Hadamard's method of shape differentiation is applied to topology optimization of a weakly coupled three physics problem. The coupling is weak because the equations involved are solved consecutively, namely the steady state Navier-Stokes equations for the fluid domain, first, the convection diffusion equation for the whole domain, second, and the linear thermo-elasticity system in the solid domain, third. Shape sensitivities are derived in a fully Lagrangian setting which allows us to obtain shape derivatives of general objective functions. An emphasis is given on the derivation of the adjoint interface condition dual to the one of equality of the normal stresses at the fluid solid interface. The arguments allowing to obtain this surprising condition are specifically detailed on a simplified scalar problem. Numerical test cases are presented using the level set mesh evolution framework of [1]. It is demonstrated how the implementation enables to treat a variety of shape optimization problems.

The final conference proceeding will synthetize the submitted paper [2] and provide a few different illustrations.

References

[1] Allaire G, Dapogny C, Frey P. Shape optimization with a level set based mesh evolution method. Computer Methods in Applied Mechanics and Engineering. 2014;282:22–53.

[2] Feppon F, Allaire G, Bordeu F, Cortial J, Dapogny C. shape optimization of a coupled thermal fluid-structure problem in a level set mesh evolution framework. 2018 Jan; working paper or preprint; Available from: https://hal.archives-ouvertes.fr/hal-01686770.