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IMMERSED VOLUME METHOD WITH ANISOTROPIC MESH ADAPTATION AND TIME-STEPPING CONTROL FOR FLUID STRUCTURE INTERACTION AND HEAT TRANSFER APPLICATIONS

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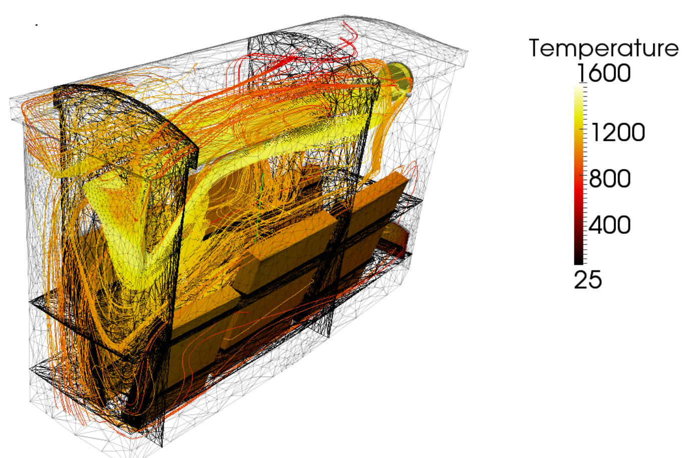

Figure 1: Streamlines' distribution inside an industrial furnace and around heated ingots.

This paper presents advancements toward a monolithic approach with anisotropic mesh adaptation and time-stepping control for the numerical resolution of fluid structure interaction applications with complex geometries. A stabilized finite element method [3, 4] is used to numerically solve time-dependent, three-dimensional, conjugate heat transfer and turbulent fluid flows.The proposed immersed volume method with the anisotropic mesh adaptation ensures an accurate capturing of the discontinuities at the fluid-solid interfaces and provides a homogeneous physical and thermodynamic properties for each subdomain. In this work we also present a novel method of building unstructured meshes for time-dependent problems, the paradoxical meshing, that generates optimal space and time meshes suitable for several simulation time subintervals. We start by introducing the classical anisotropic mesh adaptation technique proposed in [1, 2]. The latter is developed based on the length distribution tensor approach and the associated a posteriori edge based error analysis. Then we extend the mesh adaptation technique to contain adaptive time advancing. A newly developed time error estimator is constructed and intends to homogenize the global error over space and time. The advantage of the proposed method relies in its conceptual and computational simplicity as it only requires from the user a number of nodes and a frequency of adaptation according to which the mesh and the time-steps are automatically adapted. The proposed method demonstrates its efficiency and accuracy in simulating 2D and 3D unsteady heat transfers and turbulent flows inside complex geometries in the presence of conducting solids (cf. Figure 1).

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