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Coarse Grid Computational Fluid Dynamics Fire Simulations

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Abstract : While computational fluid dynamics (CFD) simulations of fire scenarios are commonly used in the design of buildings, less attention has been given to the use of CFD simulations as an operational tool for the fire services. The reason of this lack of attention lies mainly in the fact that CFD simulations typically take large periods of time to complete, and their results would thus not be available in time to be of use during an emergency. Firefighters often face uncertain conditions when entering a building to attack a fire. They would greatly benefit from a technology based on predictive fire simulations, able to assist their decision-making process. The principal constraint to faster CFD simulations is the fine grid necessary to solve accurately the physical processes that govern a fire. This paper explores the possibility of overcoming this constraint and using coarse grid CFD simulations for fire scenarios, and proposes a methodology to use the simulation results in a meaningful way that can be used by the fire fighters during an emergency. Data from real scale compartment fire tests were used to compare CFD fire models with different grid arrangements, and empirical correlations were obtained to interpolate data points into the grids. The results show that the strongly predominant effect of the heat release rate of the fire on the fluid dynamics allows for the use of coarse grids with relatively low overall impact of simulation results. Simulations with an acceptable level of accuracy could be run in real time, thus making them useful as a forecasting tool for emergency response purposes.

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