PhD position at IFP Energies nouvelles (IFPEN)
In Computer Sciences / Mechanical Engineering

High order scheme development using a Cartesian AMR solver for Large Eddy Simulation on Electric motor

Automotive industry is moving fast to offer hybrid and full electric vehicles in order to reduce the greenhouse gas emissions and pollutants. Then electric motors may be considered as one of the most important device in the next emerging vehicle architecture. Electric motor have high operating efficiency, considerable heat is generated based on required operating torque and speed. Thus, an efficient motor cooling system is needed to maintain the temperature within a prescribed range. The simulation of electric motor cooling is complex because of the reliable interactions of different physical phenomena such as: turbulence, parietal boundary layers, gas compressibility, two-phase flow (induced by liquid cooling). All these factors have to be considered that can give serious problems of numerical instability, which are often solved by using a numerical artificial viscosity. This numerical dissipation can be mainly implied by the numerical spatial scheme discretization schemes of low or explicit weight by techniques of decentralization or collocation of variables.
However, this search for stability and robustness is often at the expense of the accuracy of calculations. Indeed, for this type of simulation where the turbulence has a major effect, we usually use the Large Eddy Simulation method that distinguishing large scales - that we are trying to solve the numerical problem - and small scales - which are modeled and associated with the turbulent diffusion. For these kind of simulation, the numerical dissipation becomes critical if its amplitude exceeds that of the modeled turbulent diffusion. We can then end up with an effective Reynolds (cumulating turbulent diffusion and numerical diffusion) very far from the real Reynolds of the flow.
The objectives of this thesis is to develop a Galerkin Discontinuous numerical scheme in a Cartesian solver with automatic mesh refinement (AMR) and having the CutCell mesh-wall technology. In order to carry out the PhD work, the design of a so-called Flux Reconstruction (FR) schemes will be done which have the particularity to have demonstrated a high robustness. These schemes have the power to adapt naturally to finite volume solver and are able to allow their adaptation to non-conforming meshes.

Keywords: Computational Fluid Dynamics, Galerkin, Cartesian solver.

Academic supervisor	Dr, Vincent Perrier (INRIA Bordeaux Sud-Ouest, équipe Cagire, UPPA) Dr, Quang Huy Tran. (R11 – Digital science division, IFPEN Rueil)
IFPEN supervisor	Dr Julien Bohbot (R11 – Digital science division, IFPEN Rueil) julien.bohbot@ifpen.fr
PhD location	IFPEN 1-4 avenue du Bois Préau Rueil Malmaison – France
Duration and start date	3 years, starting in fourth quarter 2021
Academic requirements	University Master degree computer science / mechanical engineering
Language requirements	Fluency in French or English, willingness to learn French

To apply, please send your cover letter and CV to the IFPEN supervisor indicated here above.

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