Ph.D Student presentation

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General

• 25 years old
• Studied at Montpellier University
• Graduate of M2 Modelisation and Numerical Analysis

Stage

■ M2 project: I worked at the C.E.A, on ultrasonic ray for determine an optimal acoustic lens geometry

Master

■ Error a posteriori estimation of numericals schemes
■ Numerical Analysis of Hybrid High Order method
■ Optimal control
■ Advanced programmation for mathematicians
■ Numerical modelisation of the compressible Navier-Stokes équation by finite-Volume methods
Thesis goal

Context
- Ecology of urban/extra-urban areas increasingly deteriorated by noise emission generated by rotating machines (helicopters, drone delivery, winds turbines ...)

Goal
- Make efficient prediction of noise by aerodynamics and aeroacoustics simulations of rotating machines
The challenge

How?

- **Combination of:**
  
  *Hybrid turbulence model (RANS/VMS-LES) ⊕ Immersed boundary method and/or chimera method*

- **Adaptation of these methods to aeroacoustics**

- **Development of AIRONUM parallel code**
**RANS/VMS-LES**

- $\langle W \rangle$: variables related to RANS approach
- $W^c$: fluctuation resolved
- $W'$: small scale variables resolved

\[
\left( \frac{\partial W}{\partial t}, \chi_i \right) + \left( \nabla \cdot F_c(W), \chi_i \right) + \left( \nabla \cdot F_v(W), \phi_i \right) = \\
- \theta(\tau^{\text{RANS}}(\langle W \rangle), \phi_i) - (1 - \theta)(\tau^{\text{LES}}(W'), \phi'_i)
\]

- $F_c$: convective flux treated by finite volume
- $F_v$: viscous flux treated by finite element
- $\tau^{\text{LES}}(W')$: closing LES term
- $\tau^{\text{RANS}}(\langle W \rangle)$: closing RANS term
- $\theta$: RANS/VMS-LES hybridation function in $[0,1]$
## A priori planning

- **1\textsuperscript{st} year:**
  - Bibliography (numerical models used, chimera method, immersed boundary method)
  - Getting started with the AIRONUM code
  - Adaptation of hybrid turbulence model for aeroacoustics

- **2\textsuperscript{nd} year:**
  - Multirate time advancement method
  - Implementation of the immersed boundary method
  - Flow simulations around a helicopter rotor

- **3\textsuperscript{rd} year:**
  - Finalization of flow simulations
  - Thesis redaction