

Présentation du projet ANR ECINADS

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Objective

The objective of the project is improve the efficiency and in particular the scalability of numerical algorithm and software simulating unsteady turbulent flows, together with their adjoint systems.

Demonstrators :

The models will

- have state-of-art hybrid turbulence modelling,
- run on massive parallel computers in a scalable mode,
- for one of them : be quasi-Automatically Differentiable and allow, by adjoint-based methods, lower numerical errors.

Three kernels

- NSMB : structured, multiblock compressible with hybrid OES-RANS
- ANANAS : unstructured multi-fluid
- AERO : unstructured compressible with hybrid VMS-RANS

Three topics in three disciplines need be advanced :

(1)- scalability will be addressed :

(1a) Global preconditioning (coarse grids)

(1b) Local preconditioning

(2)- Investigation of new hybrid turbulence models using error correctors and adjoint-based mesh adaptation

(3)- Automatic differentiability will be obtained by adapting the CFD algorithm and by improving the AD tool TAPENADE in the direction of :

(3a) Storage-recomputing functionalities,

(3b) Optimized differentiation of MPI messages.

Thèse 1 : Hubert Alcin, INRIA : Algorithmes scalables et adjoints

Phase 1 (12 mois) :

Algorithmes scalables pour les modèles elliptiques.

Phase 2 : Adjoint parallèle scalable.

C1.1 accurate specification of solution algorithms useful for the three calculations of state, linearised state, adjoint, C1.2 strategies for restoring state values (from memory or from recomputation), any linear or nonlinear fixed point iteration needs the storage of state in order to get a perfectly exact adjoint. The study will compare a perfectly exact strategy with more efficient ones (and more approximate), C1.3 strategies for assembling adjoint : we plan to apply the II-loop method [Courty et al.], C1.4 strategy for adjoining (part of) solution algorithms, C1.5 strategies for MPI [Utke et al.], C1.6 strategies for the implementation of storage-recomputing with the help of AD, C1.7 application to static mesh adaptation : the adjoint state is used into a calculus of variation [Dervieux et al. 2007] specifying explicitly the optimal mesh for an accurate drag evaluation.

Thèse 2 : Alexandre Carabias, INRIA : Algorithme multi-fluide scalable
Co-encadrement Lemma.

Phase 1 :

Approximation et résolution scalable de l'advection d'une level set.

Phase 2 :

Algorithme de résolution et adaptation scalable.

Thèse 3 : Carine Moussaed, UM2 : Algorithmes implicites scalables pour les modèles fluides compressibles.

- C3.1. sub-domain preconditioners adapted to boundary layers : study of ILU(k) types,
- C3.2. sub-domain numberings adapted to boundary layers,
- C3.3. coarse grids : comparison of Multi-grid (MG) and Deflation Preconditioning (DP),
- C3.4. application to new flow cases.

Thèse 4 : IMFT : Algorithmes implicites scalables pour les méthodes bloc-structurées :

- C4.1. implicitation of hybrid models with anisotropic RANS,
- C4.2. application to particular sub-domain preconditioners of NSMB,
- C4.3. study of one of two coarse-grid methods,
- C4.4. application to new flow cases.

Task decomposition

Task 1 : Coordination and dissemination

Task 2 : Global preconditioning by coarse grid : I3M, INRIA, Lemma

Task 3 : Subdomain preconditioning : INRIA, All

Task 4 : Assembly of both preconditioners (in accordance to AD strategy) : INRIA, All

Task 5 : Parallel reverse differentiation and checkpointing by AD : INRIA, I3M

Task 6 : Turbulence models : IMFT, I3M, INRIA

Task 7 : Assessments and applications : Lemma, All

Mise en œuvre

- Octobre 2009 :

Réunion de démarrage.

Démarrage de la thèse de Hubert Alcin sur les algorithmes.

Lemma et UM2 participent à l'encadrement.

Évolution prévue vers l'AD en octobre 2010.

- Stage printemps 2010 : Alexandre Carabias à Lemma.

- Octobre 2010 :

Séminaire ECINADS 27 octobre. Deux conférences invitée + séminaire de H. Alcin.

Reunion ECINADS 28 octobre.

Démarrage de trois autres thèses :

- Carine Moussaed à Montpellier 2,

- Alexandre Carabias à l'INRIA,

- Fernando Grossi à l'IMF-Toulouse.

L'accord de Consortium a circulé chez les partenaires depuis 16/08/2010.

Accord de Lemma.