Advanced Reduced Order Methods with Applications in Computational Fluid Dynamics

AROMA-CFD: ERC COG 2015 - GA 681447 - Panel PE1, Mathematics

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Aim of AROMA-CFD

- To create a team of scientists at SISSA for the development of Advanced Reduced Order Modelling techniques with a focus in Computational Fluid Dynamics (CFD).
- To face and overcome many current limitations of the state of the art and improve the capabilities of reduced order methodologies for more demanding applications in industrial, medical and applied sciences contexts.
- AROMA-CFD deals with strong methodological developments in numerical analysis, with special emphasis on mathematical modelling and an extensive exploitation of computational science and engineering.

Research staff

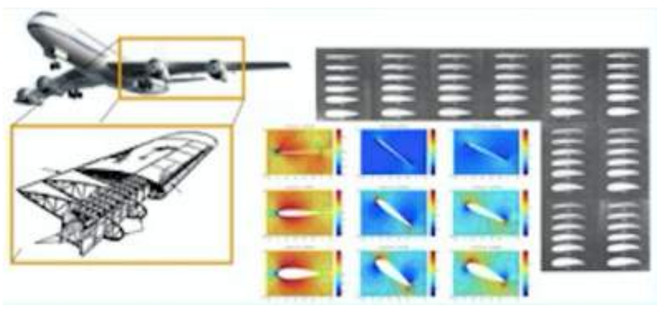
Research associate:
- Francesco Ballarin
- Giovanni Stabile
- Martin Hess
- Marco Tezzele

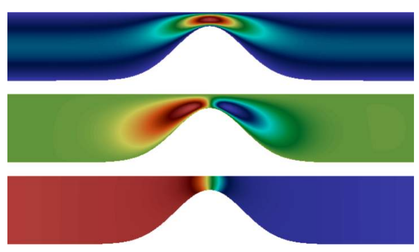
Master students/internship:
- Maria Strazzullo
- Matteo Zancanaro
- Giacomo Zuccarino
- Nirav Vasant Shah

Students/collaborators:
- Federico Pichi
- Saddam Hijazi
- Zakia Zainib
- Shafqat Ali
- Giovanni Corsi
- Filippo Salmoiraghi
- Andrea Mola

Tasks in reduced order modelling developments

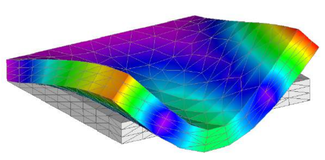
- Study of bifurcations and instabilities in flows.
- Increase Reynolds number while guaranteeing the flow stability.
- Move towards parametric turbulent flows.
- Consider complex geometrical parametrizations of shapes as computational domains as well as extended networks.
- Special focus on nonlinear inverse problems, focusing on optimal flow control, shape optimization and uncertainty quantification.

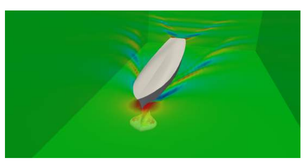


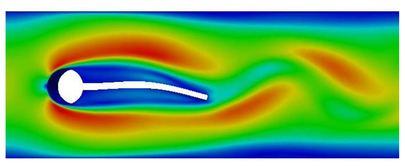


Applications in multiphysics

Advanced developments in reduced order modelling for CFD will be delivered for applications in multiphysics, such as:
- Fluid-structure interaction problems.
- More general coupled phenomena involving inviscid, viscous and thermal flows, solids and porous media.

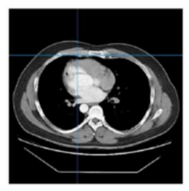


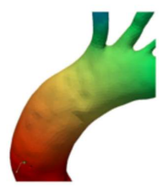


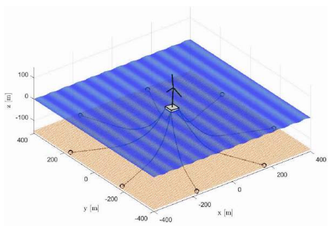


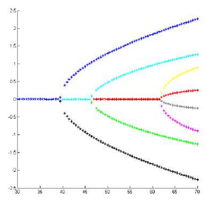
Industrial and medical applications

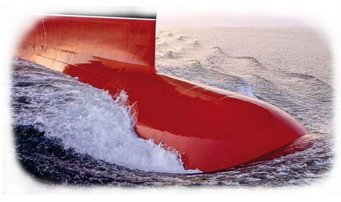
- Aeronautical, mechanical, naval, civil, off-shore, wind, sport, biomedical engineering with a focus on cardiovascular surgery applications.

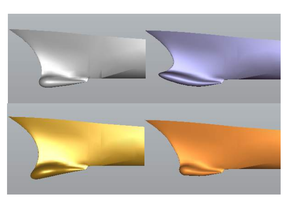












- Towards real-time computing and visualization, through an offline-online computational paradigm that combines high performance computing (in dedicated supercomputing centers) and advanced reduced order modelling techniques (in common devices such as tablets and smartphone).

Collaborations

SISSA mathLab, MIT, University of Toronto, Houston, Sevilla, Konstanz, Stuttgart, Pavia, Trento, Florida State University, Sandia National Laboratories, Politecnico di Milano, Torino, Paris VI UPMC, EPFL, ETHZ, Ospedale L. Sacco.

Software

A new open source software library for AROMA-CFD will be created: ITHACA, In real Time Highly Advanced Computational Applications, enhancing current RBniCS educational and training capabilities.

RBniCS can be found here: http://mathlab.sissa.it/rbnics

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