Multifidelity aeroelastic optimization with application to a BWB.

Gilberto RUIZ JIMÉNEZ[1];
Joan MAS COLOMER; Joseph MORLIER
1,2: ISAE-SUPAERO, Université de Toulouse, France 3: ICA, ONERA, France
1. gilberto.ruiz-jimenez@student.isae-supaero.fr

1. Introduction

- Fluid-Structure interaction optimization problems are often hard to solve.
- MDO libraries allow the user to couple both disciplines and optimize w.r.t. established bounds and variables [1].
- Hi-Fi simulations offer accurate results but are often too expensive for direct design optimizations.
- Lo-Fi analysis offer reasonable approximations with low computational demands.
- Multifidelity methods leverage error and costs to speedup simulations [2].
- The purpose of this work is to implement the aforementioned techniques to the development of a BWB concept aircraft.

2. Proposed Method

- The base for the code development is the aerostructures package [3], which facilitates the creation of MDAO problems in OpenMDAO.
- Open-source structural (NASTRAN) and fluid solvers (Panair, ADFlow) are coupled via the displacement field of the structure, then optimized w.r.t. CDi (Fig. 1).
- At this stage the only difference between fidelities then is the size of the fluid mesh.
- The philosophy is to build a progressively complex model, making sure that everything works at each step.

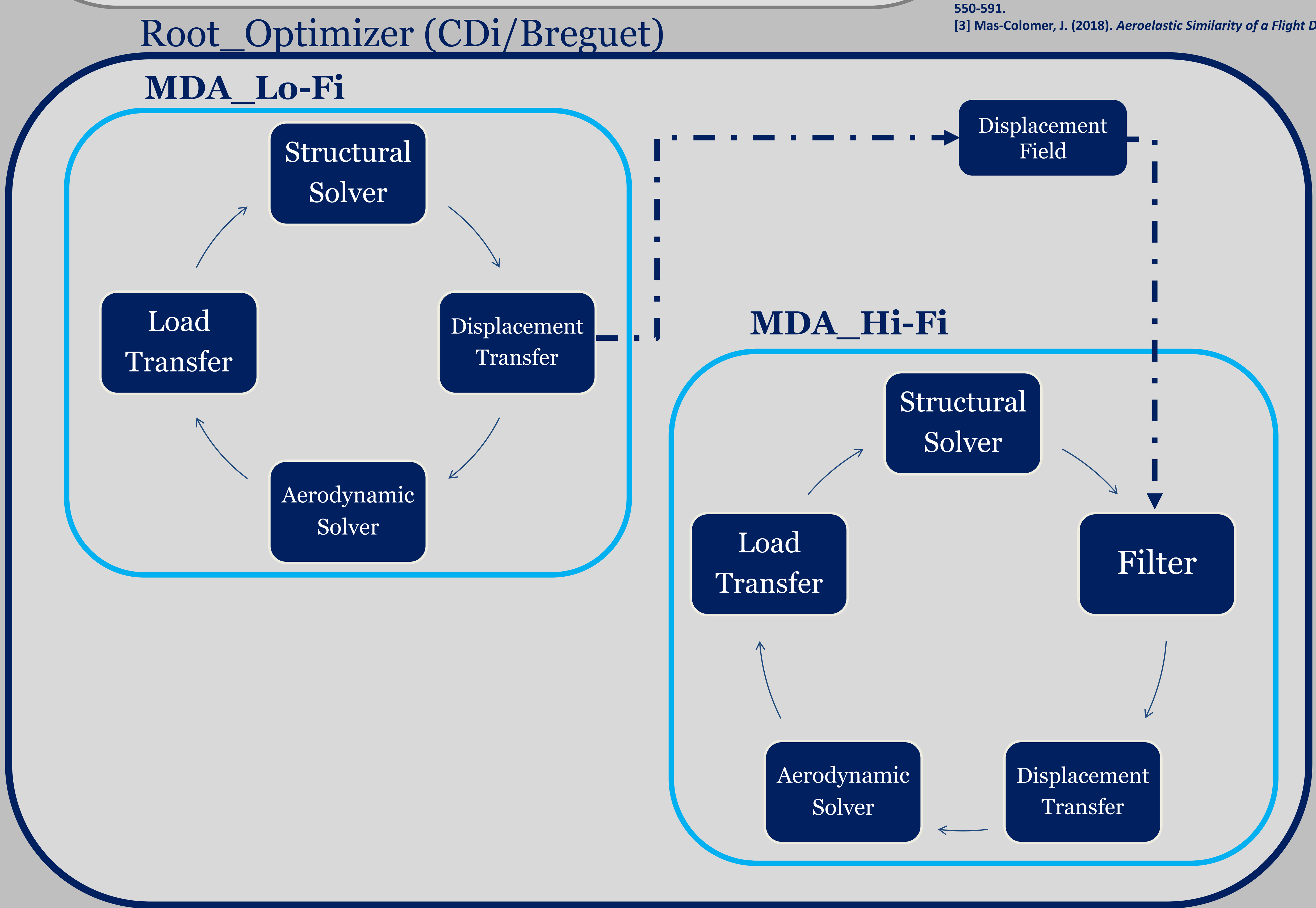

Fig. 1 MDAO Diagram for the multifidelity scheme.

3. Preliminary Results

- Different iteration limits were set at the Lo-Fi levels to evaluate the evolution of the total execution time for a sample problem.
- Fig. 2 shows the combination of iterations required for convergence of the linked MDA as well as the time to converge.
- Accelerating the process is possible.
- Iteration-based control → residual-based control for optimum performance.
- The resulting shape and stress field is similar for all cases (Fig. 3).

4. Project Milestones

- [x] Write the code that connects both fidelity levels in OpenMDAO.
- [x] Run the multi-fidelity optimization for the sample case.
- [ ] Check performance of the new proposal vs. previous code and single fidelity.
- [ ] Apply the method to a BWB configuration and validate the results.
- [ ] Check for possible performance improvements for the complex case.

[1] Gray, J., Moore, K., & Naylor, B. (2010, September). OpenMDAO: An open source framework for multidisciplinary analysis and optimization. In 13th AIAA/ISSMO Multidisciplinary Analysis Optimization Conference (p. 9101).
[2] Peherstorfer, B., Willcox, K., & Gunzburger, M. (2018). Survey of multifidelity methods in uncertainty propagation, inference, and optimization. SIAM Review, 60(3), 550-591.
[3] Mas-Colomer, J. (2018). *Aeroelastic Similarity of a Flight Demonstrator via Multidisciplinary Optimization* (Doctoral dissertation, Université Fédérale de Toulouse).

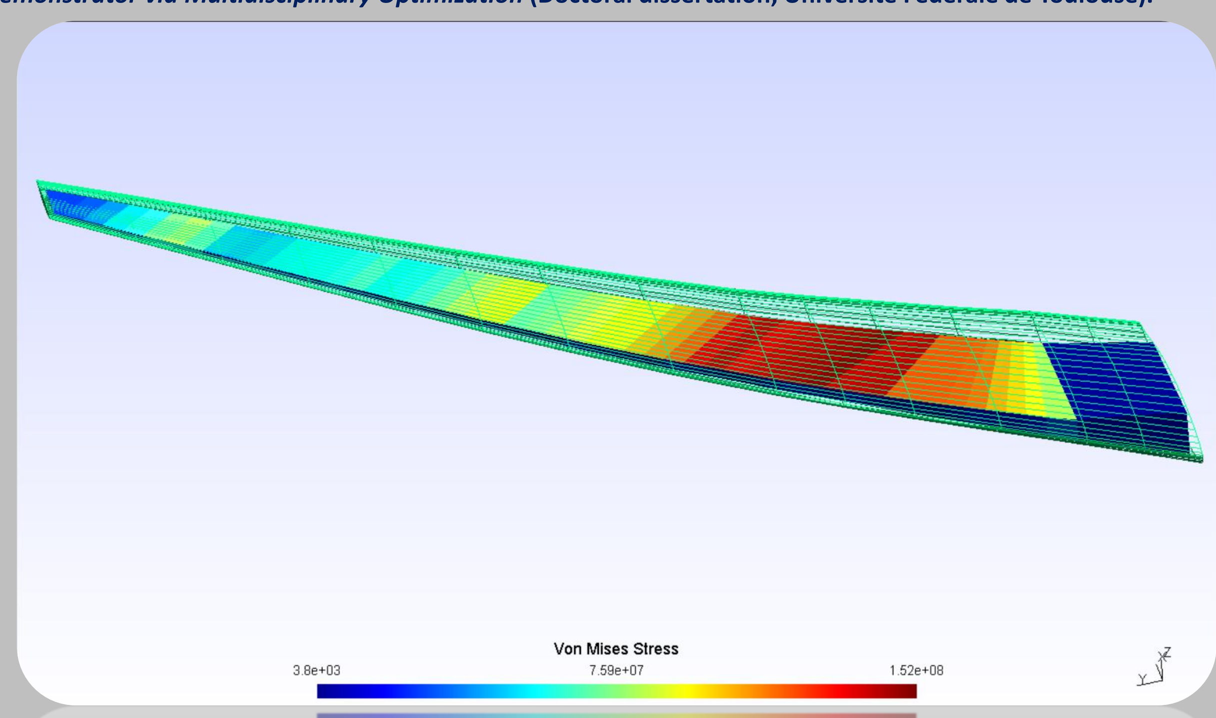

Fig. 3 Equivalent stress over an optimized wing .

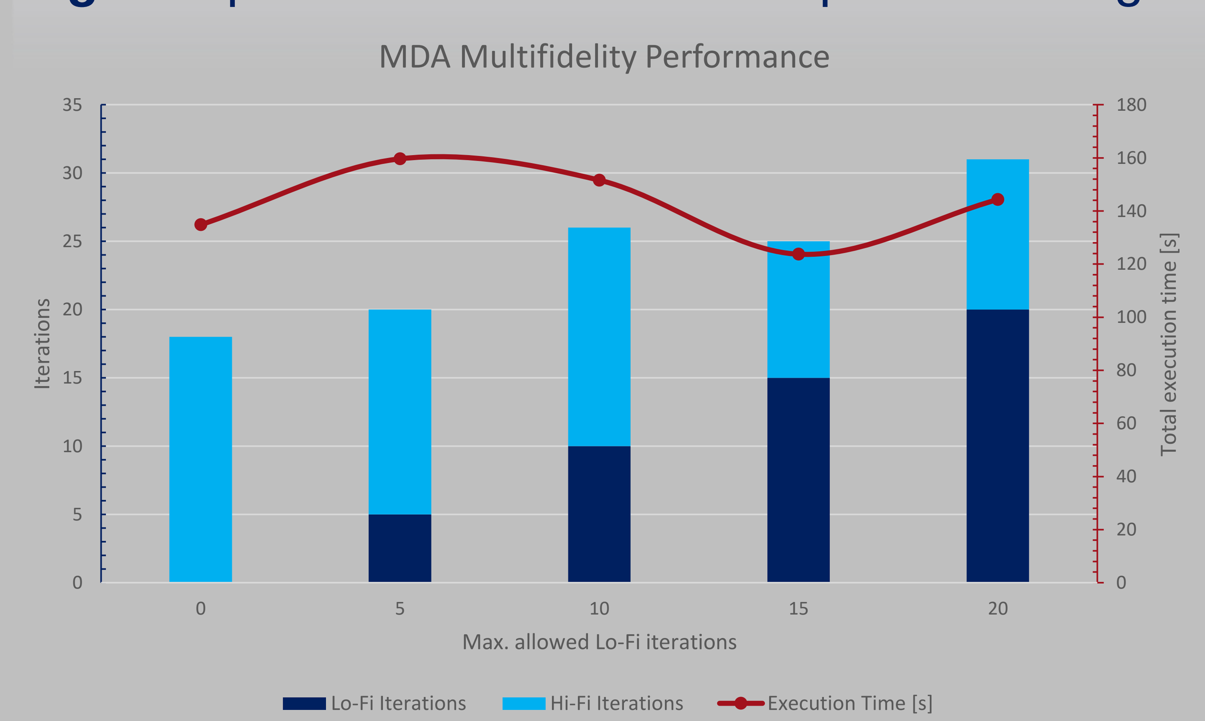

Fig. 2 Performance plot of the current MDA multifidelity system.