MDAO Working group

Multi-Disciplinary Analysis and Optimization

Ruben Sanchez

SU2

Key initiatives

- The goal is to provide a seamless, open-source toolkit for computing primal and adjoint solutions of industry-relevant, Fluid-Structure Interaction problems
- We will explore the (native) integration of TACS with the Discrete Adjoint Driver
- Answer the question of whether the python wrapper provides the same sensitivities as the native approach for the exact same simulation case
- Evaluate robustness of both approaches (fix-point iteration and consistency)
- We agree that there may be more than one approach, but the common elements of the different approaches should be tackled together by the community
    - Mesh deformation
    - Solution interpolation
    - Communication infrastructure

Some personal comments...

- **Regarding C++ SU2 core:** I've had a lot of great user feedback on the native implementation, particularly for usability reasons. It is also a massive advantage from the development point of view to have multi-physics integrated, especially regarding sensitivities.
- **Regarding Python Wrapper:** As of now, there is a limited number of functions for input/output data. The current version does not work with the AD-compiled binaries (I'm working on that).
- **Regarding Interpolation frameworks:** Robustness and clear interfaces for interpolation are of capital importance. It could also be interesting to have a light tool that we could ship with the main code. It's very important to realize that adjoint sensitivities will require a different set of operations than primal solvers, and both need to be accounted for.
- **Regarding External solvers:** They are necessary for large, industrial cases. Making them work with coupled adjoints will most likely require access to source code. TACS is a fantastic candidate, we could leverage on the collaboration between both communities. We should devise a strategy to for the framework to be usable (and not a sequence of hacks). I would be in favor of sticking to open-source.

Envisioned code requirements

- An integrated mesh deformation solver for mesh sensitivities.
- An improved definition of objective functions and magnitudes of interest in SU2.
- Clear interfaces for the coupling magnitudes and the sensitivities using python or native methods.
- A clearly defined interpolation framework for operation on the sensitivities, using python or native methods.
- A further development of the native solver, to exploit the competitive advantage of having everything on the same code-base for testing, usability and maintenance.
- A working python-wrapper with the AD version of the code, and a definition of the interpolation.
- An external, non-linear beam-solver, for initial implementation, testing, application to relevant (wing) test cases, and self-contained deployment of the framework (collaboration TU-KL - UC3M).
- Link to TACS (which might require some modifications in the sources) for application to larger cases. Evaluate whether to integrate TACS via source or via python (adjoint robustness and fixed-point).
- A complete reformulation of the python optimization framework.

Working group members

Points of Contact:

- Dr. Ruben Sanchez
- Professor Juan Alonso

Participants at the 4th Developers Meeting

- Stanford University - Prof. Juan Alonso
- University Carlos III Madrid - Prof. Rauno Cavallaro, Rocco Bombardieri
- Bosch - Tobias Kattmann
- Imperial College London - Prof. Rafael Palacios
- TU Braunschweig - Prof. Ali Elham
- TU Delft - Nitish Anand
- NIA - Dr. Heather Kline
- University of Liege - Prof. Vincent Terrapon
- TU Kaiserslautern - Prof. Nicolas Gauger, Dr. Ruben Sanchez, Ole Burghardt

Email addresses on request

Next steps

- Telecom Wednesday, May 15th
    - 8:00 PST / 16:00 BST / 17:00 CEST
    - Topic: Integration SU2/TACS

- Distribution of tasks

1st Telecom Attendees

- Ruben Sanchez (TU KL)
- Rocco Bombardieri (UC3M)
- Vincent Terrapon (ULiege)
- Mariano Sanchez (ULiege)
- Rafa Palacios (ICL)
- Pedro Gomes (ICL)
- Charanya V-Crome (ICL)
- Pedro Gomes (ICL)
- Nitish Anand (TU Delft)
- Graeme Kennedy (GeorgiaTech)
- Juan J. Alonso (Stanford University)
- Ole Burghardt (TU KL)
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