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GLOBAL STABILITY ANALYSIS OF INDUSTRIAL COMPRESSIBLE FLUID FLOWS

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The comprehension of unstable fluid flows can generally be enhanced by a global stability analysis. After having found a fixed point of the governing equations, it consists in solving an eigenvalue problem coupled with shift-and-invert transformation, which requires multiple inversions of large sparse complex-valued linear systems. A usual strategy lies on direct factorizations that, on systems exceeding 10^6 degrees-of-freedom, lead to memory overflow. To overcome this limit, the use of preconditionned iterative algorithms [1] becomes mandatory. Furthermore, as complex arithmetic loops can't be vectorized, complex systems need to be rewritten to preserve HPC optimizations, for which important works are currently done at ONERA.

To ensure the preservation of loop optimizations, the linearized matrix-vector products used to form the eigenvalue problem are obtained by means of Algorithmic Differentiation [2] in the method we developed. Furthermore, we reformulated the complex problem in an equivalent real formulation which saves vectorization despite doubling the problem's size. And to preserve the sparsity patterns of the considered operators and thus allow the reuse of most advanced preconditionning techniques [3], the K formulation [4] has been chosen. The reformulated eigenvalue problem is solved by mean of a Krylov-Schur algorithm where inversions are managed by the GMRES algorithm. This presentation shows a complete description of the developed global stability method and its validation on reference configurations.

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