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Adjoint Based Anisotropic Mesh Adaptation for Turbomachinery Applications

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Adaptive methods have been widely used in aeronautics to improve the predictions while minimizing the CPU cost. They are used to deal with complex phenomena (sonic-boom, vortices, ...), or to guarantee the optimal (second) order of convergence of the numerical scheme, especially when discontinuities (shocks waves) are present in the flow field [1]. Mesh adaptation now tends to spread in industrial applications but its application to turbomachinery applications is limited to a few attempts due to some particularities of these applications.

Turbomachinery involves different complex flows of very small scale (jets, boundary-layers, shock,...) with a strong impact on performance[3]. These flow features are not known *a priori* and require an appropriate discretization of the domain. Mesh adaptation is thus particularly appropriate for such applications and becomes even more practical when many meshes are required as for design optimisation and performances study. However, in order to handle all these features together, a special care must be taken in the whole adaptation cycle. The periodicity, rotating frames and RANS equations have to be taken into account in the primal and adjoint solver and in the error estimators to prescribe an appropriate mesh size. The periodicity also has to be taken into account in the mesh adaptation step to guarantee the periodicity of the computational domain. Any modification of the mesh on one side of the domain has to be applied to the other side, which has strong impacts on traditional mesh operators (smoothing, boundary layer generation,...)

We will show how mesh adaptation can be applied to RO37 and LS89 test cases, improving solutions quality and the inherent difficulties of periodic mesh adaptation and how they can be resolved.

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