A tearing-and-coupling approach to the construction of POD-ROMs for industrial turbines

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This work is a follow-up of a recent paper devoted to the construction of efficient reduced-order models (ROMs) for flows imposed by solids in forced rotation with a focus on industrial applications (fans, compressors, agitators, etc.). We use the well established Proper Orthogonal decomposition (POD) associated with a standard Galerkin projection of the monolithic (fluid/solid) governing equations. However, the required number of Proper Orthogonal Modes (POMs) necessary to achieve an acceptable reconstruction of the fluid flows is very high due to the strong evolution of the solution in the vicinity of the rotating solid. In this work, we propose a divide and conquer strategy as follows. First, the computational domain is decomposed in two overlaping subdomains: (i) a rotating subdomain in the vicinity of the solid with same ensemble rotation velocity, and (ii) a fixed subdomain associated with the rest of the domain. Second, we adapt the previously proposed POD-ROM to account for the rotation of the domain. Here, the reduction occurs for the rotating subdomain only. Third, we adapt the standard Restricted Additive Schwarz (RAS) method to couple both the POD-ROM solution in the rotating subdomain with the high fidelity solution in the immovable domains. This approach allows to efficiently reduce the computational cost associated with the turbines only with a high accuracy. Results are shown for a 2D academic application (rotation of an ellipse) and for a 3D industrial application (steel quenching tank agitator).

Key-words: *Turbines, Reduce-Order Model, Proper-Orthogonal Decomposition, Domain Decomposition*