Abstract:
The present work searches for suitable iterative solvers for problems in thermoacoustics. In particular, Helmholtz equations and discontinuous-Galarkin-discretized linearized Navier-Stokes equations (DG-LNSE) were treated. The literature related to iterative solvers is summarized, and suitable solvers were identified. Multiple solvers were found to work for the Helmholtz equation and LNSE with no heat source term. On the other hand, none of the tested solvers (GMRES, FGMRES, BiCGStab, CG) worked for the more complex LNSE problems involving a heat source term, regardless of used preconditioner. For Helmholtz eigenvalue problems, numerical investigations revealed that conjugate gradient (CG)–with the Multigrid method as a preconditioner–scales particularly slowly in terms of memory consumption with increasing problem size (number of DoF), leading to significant memory savings when compared to direct solvers. In particular, for 3D problems, CG with Multigrid is shown to solve problems one order of magnitude larger than MUMPS (a parallel direct solver) can solve with for same memory requirement. As for 2D problems, CG With Multigrid solves problems twice as large as MUMPS solves for the same memory requirements. Additionally, CG with Multigrid is as fast or faster than direct solvers for these equations. An alternative solver for Helmholtz eigenvalues was also studied, namely CG with SOR. This latter configuration was found to be effective, too, though less than CG with Multigrid. For
3D problems, CG with SOR was shown to solve problems that are five times larger than those that MUMPS can solve for the same memory requirements. For 2D problems, it solves problems that are twice as large as those that MUMPS can solve. However, for Helmholtz eigenvalue problems, CG with SOR is slower than MUMPS by one order of magnitude for 3D problems, and two orders of magnitude for 2D problems. For DG-LNSE frequency response problems with no heat source terms, GMRES with the SOR method as preconditioner was found to be suitable. It is shown to solve problems one order of magnitude higher than MUMPS can solve for the same memory usage, while being about 3 times slower. For the studied DG-LNSE problems with heat source terms, no iterative solvers converged. However, this is suspected to be a result of poor choice of boundary conditions in the used test cases. Nevertheless, GMRES with SOR was the nearest solver to convergence. This area requires further investigation.

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Occurences:
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