Linear Stability Analysis of Lid Driven Flows Accelerated by an Efficient Fully Coupled Time-Marching Algorithm

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Following a suggestion of adopting an existing time-stepping code to perform various bifurcation-stability tasks [1], we investigate the potential application of time-marching algorithm to study a problem of stability of steady flow developing inside lid driven cavities. The time-marching solver is based on an *LU* factorization of the Stokes operator, defined on the whole computational domain. The *LU* factorization is carried out by a direct multifrontal sparse solver (we use the MUMPS package). Thereby no pressure-velocity decoupling techniques are implied and the problem is treated in a fully pressure-velocity coupled manner. The second order finite volume method is utilized for spatial discretization of a computational domain.

The implicit linear step of a developed time-stepping code [2] serves as highly effective preconditioner for solving linear systems involving the full Jacobian for traditional Krylov-subspaces-based iteration methods. Combining this technique with Newton method and with Arnoldi iteration allows for steady state solution, direct calculation of bifurcation points and linear stability analysis.

The presented 2D stability analysis results are in good agreement with previous works [3,4] performing an extended review of lid driven flows in the rectangular cavities. The developed approach provides also a first incursion in stability analysis of 3D configuration. However, because of extremely high memory consumption as for now the algorithm is restricted only to 50^3 grid resolution, which is insufficient for obtaining quantitatively reliable results [3]. Nevertheless, taking into account a rapid increase in accessibility to massively parallel supercomputers and minor changes necessary to parallelize the developed algorithm it has a great potential an should not be immediately neglected.

References

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