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Wavelet BEM for large-scale Stokes flow simulation

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Summary

Traditional boundary element methods (BEMs) suffer from densely populated system matrices. In recent years, acceleration techniques like the wavelet BEM (WBEM) have been developed which reduce the complexity considerably. In WBEM, one uses appropriate wavelet bases for the discretization, yielding numerically sparse matrices which result in extremely fast matrix-vector multiplications. However, in conventional WBEM the wavelets are constructed by uniform refinement of parametrically described patches. Such approaches have difficulties in dealing with practical problems with complicated geometries because patch-wise surface parameterization is generally not available. To avoid this limitation, Tausch proposed a method in [1] to construct wavelets directly on the usual boundary element partition. Such an approach has greatly expanded the application scope of the WBEM. For recent development of this new WBEM, the readers are referred to [2,3].

In this talk, the new WBEM is extended to large-scale simulations of three-dimensional Stokes flow problems. The direct Stokes boundary integral equation is discretized by the Galerkin scheme which uses only one set of wavelet basis. A method for the efficient compression of the double-layer integral operator is proposed. In addition, a compression strategy for further reducing the setting-up time for the sparse system matrix is also developed. With these new developments, the method has demonstrated a high matrix compression rate for problems with complicated geometries. The performance of the method is illustrated by several examples concerning the modeling of damping forces acting on MEMS resonators.