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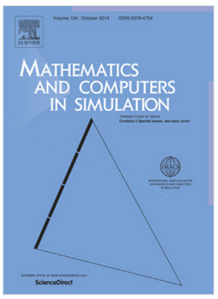

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Fast multipole singular boundary method for Stokes flow problems

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Abstract

This paper firstly employs the fast multipole method (FMM) to accelerate the singular boundary method (SBM) solution of the Stokes equation. We present a fast multipole singular boundary method (FMSBM) based on the combination of the SBM and the FMM. The proposed FMSBM scheme reduces CPU operations and memory requirements by one order of magnitude, namely $O(N)$ (where N is the number of boundary nodes). Thus, the strategy overcomes costly expenses of the SBM due to its dense interpolation matrix while keeping its major merits being free of mesh, boundary-only discretization, and high accuracy in the solution of the Stokes equation. The performance of this scheme is tested to a few benchmark problems. Numerical results demonstrate its efficiency, accuracy and applicability.

***Keywords*:** Fast multipole method; Singular boundary method; Meshless boundary collocation method; Stokes flow problems.

1 Introduction

As a classical problem in fluid dynamics, Stokes flow has frequently been applied to the simulation of incompressible creeping flows with low Reynolds number. Using vorticity and velocity technique, the governing equation of the steady Stokes flow can be converted into a system of the Laplace and Poisson-type equations, which reduces the computational complexity of the pressure.

The solution of the Stokes flow problems is the first step in the simulation of the nonlinear incompressible Navier-Stokes equation [3]. In recent years, there have been growing interests on using meshless methods for the Stokes equation [13, 30, 33]. The key feature of meshless methods is the absence of an explicit mesh and

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