Parallel CUDA Implementation of a Numerical Algorithm for Solving the Navier-Stokes Equations Using the Pressure Uniqueness Condition

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Abstract: Two numerical methods for solving the Navier-Stokes equations in doubly connected domains are studied. The first method is based on constructing a difference problem in variables of the stream function and the vortex of velocity using the uniqueness condition for pressure. The numerical solution of the elliptic equation for stream functions is found as the sum of the solutions of two simple problems of an elliptic type. One problem is with homogeneous boundary conditions, and the other is with a homogeneous equation. An alternative approach to solving the problem is the fictitious domain method with the continuation of the least coefficient. This method does not require satisfying the pressure uniqueness condition, and is simple to implement.

A computational finite difference algorithm for solving an auxiliary problem of the fictitious domain method has been developed. The results of numerical modeling of the two-dimensional Navier-Stokes equations by the fictitious domain method with continuation by the lowest coefficient are presented. For this problem, a parallel algorithm was developed using the CUDA architecture, which was tested on various grid dimensions.

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