Progress Report

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2018.12.05

1 Implementation of direct-forcing immersed boundary method (DFIB) in C++ using finite volume method with subgrid method

The three-dimensional solver for Navier-Stokes equations has been modified to implement direct-forcing immersed boundary method. A test case was run for a small cubic cavity with a sphere in the middle. The diameter of the sphere is half the length of the sphere. The size of the computational grid for this test case is $20 \times 20 \times 20$ with a subgrid of $10 \times 10 \times 10$ for the solid sphere. Another test case was run with a nonuniform grid of $16 \times 16 \times 16$ and a subgrid of $20 \times 20 \times 20$.

1.1 Results

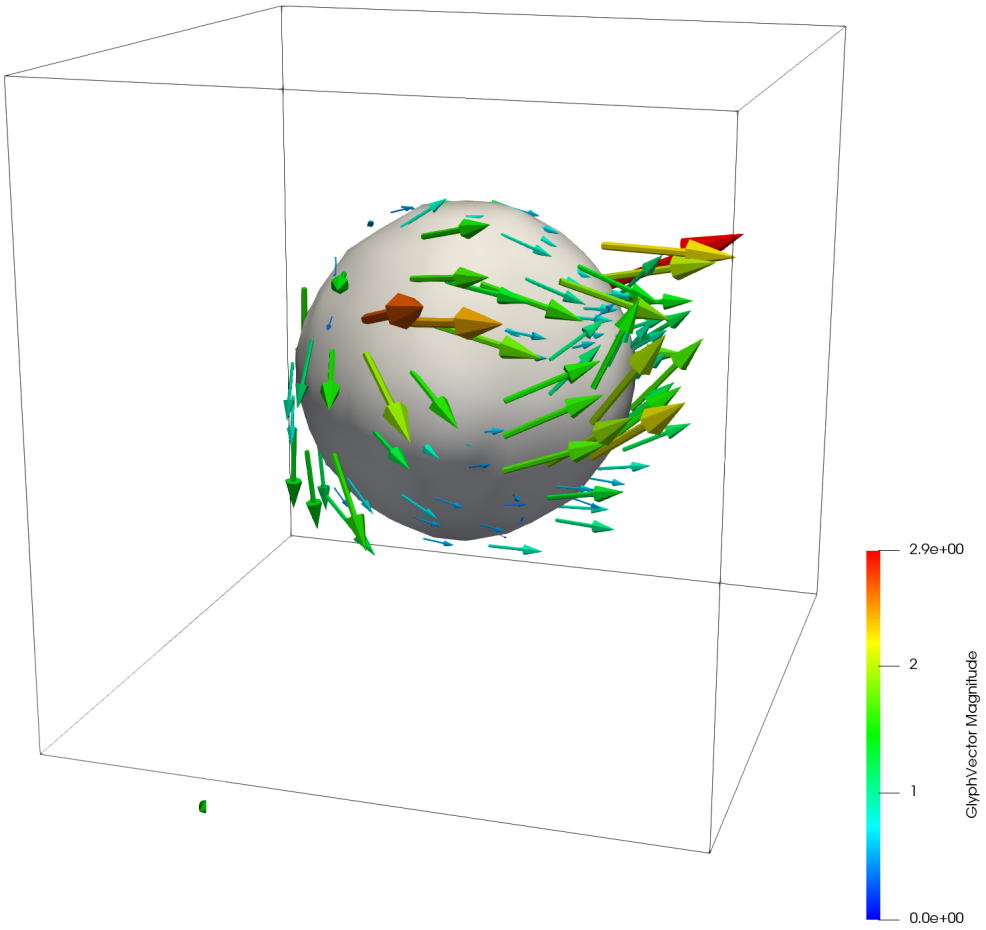

Figure 1: Virtual force vectors, $\eta \boldsymbol{f}$, plotted on the surface of the sphere in a cubic cavity with $20 \times 20 \times 20$ grid.

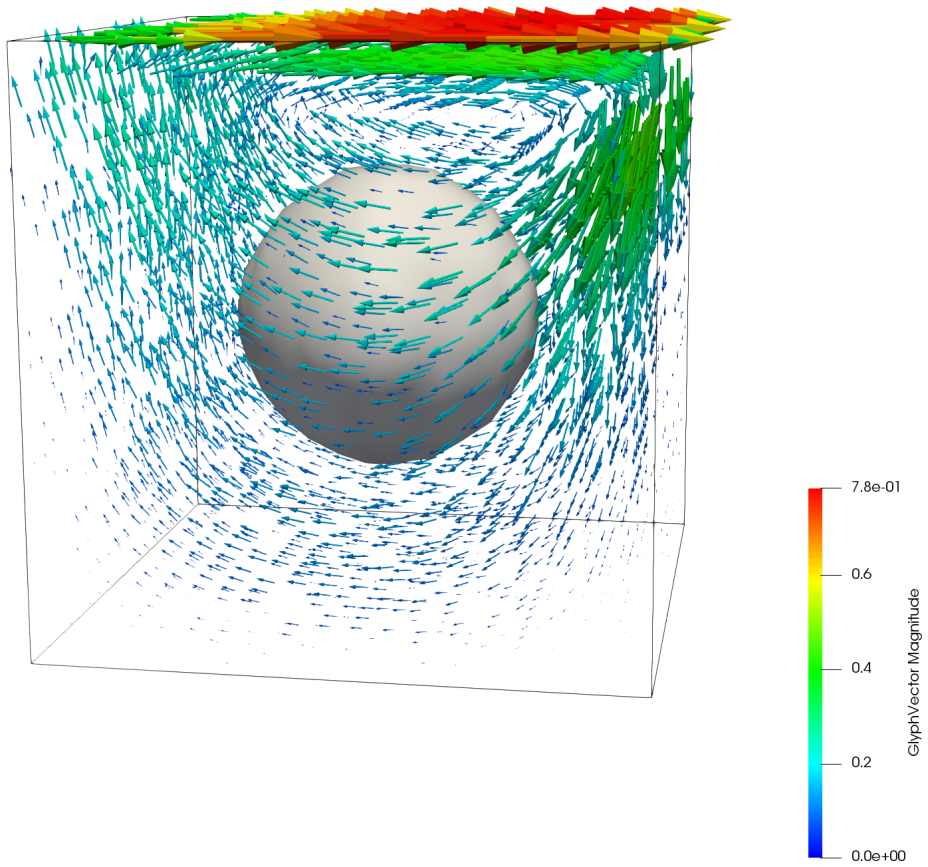

Figure 2: Velocity vectors plotted around the sphere in a cubic cavity with a $20 \times 20 \times 20$ grid.

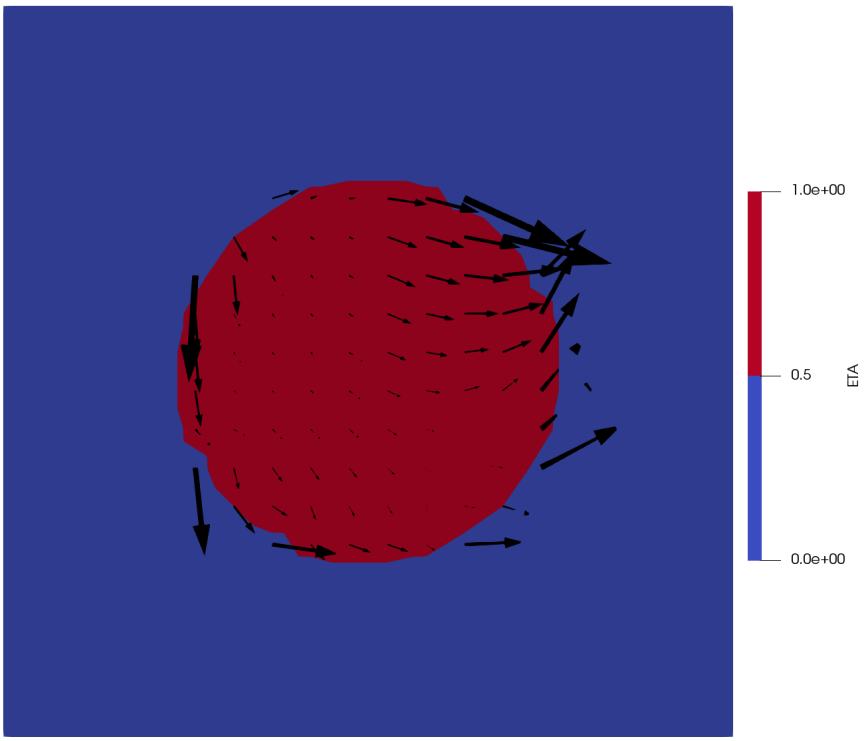

Figure 3: Virtual force vectors, $\eta \boldsymbol{f}$, plotted on the xy-plane at the center of the cubic cavity with a $20 \times 20 \times 20$ grid.

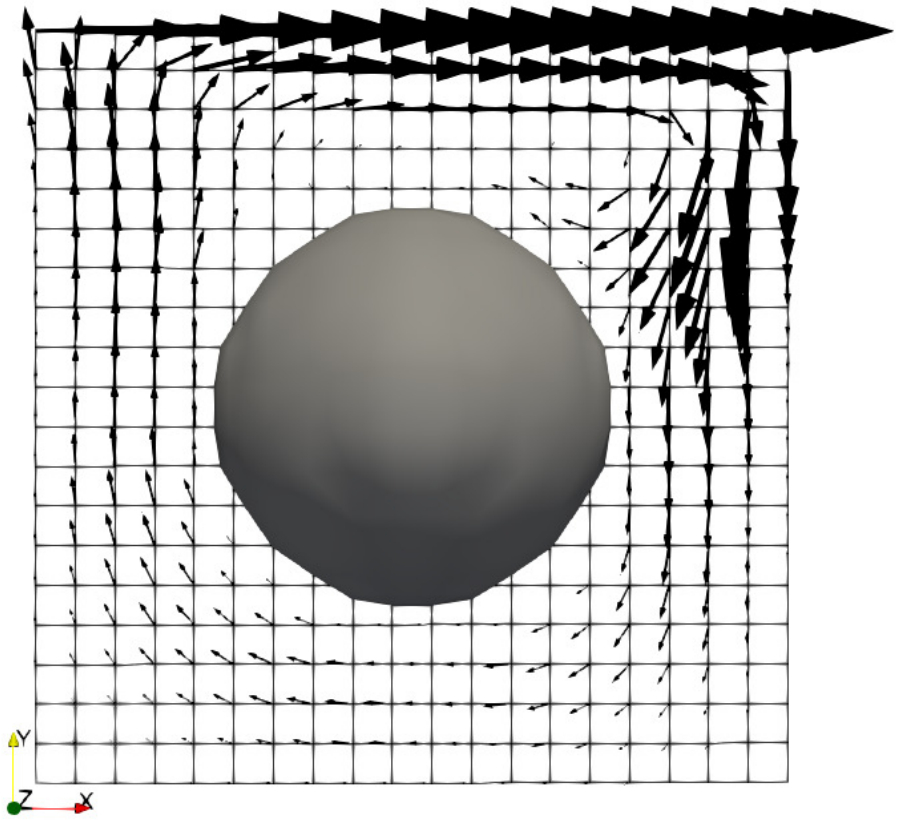

Figure 4: Velocity vectors plotted on the xy-plane at the center of the cubic cavity with a $20 \times 20 \times 20$ grid.

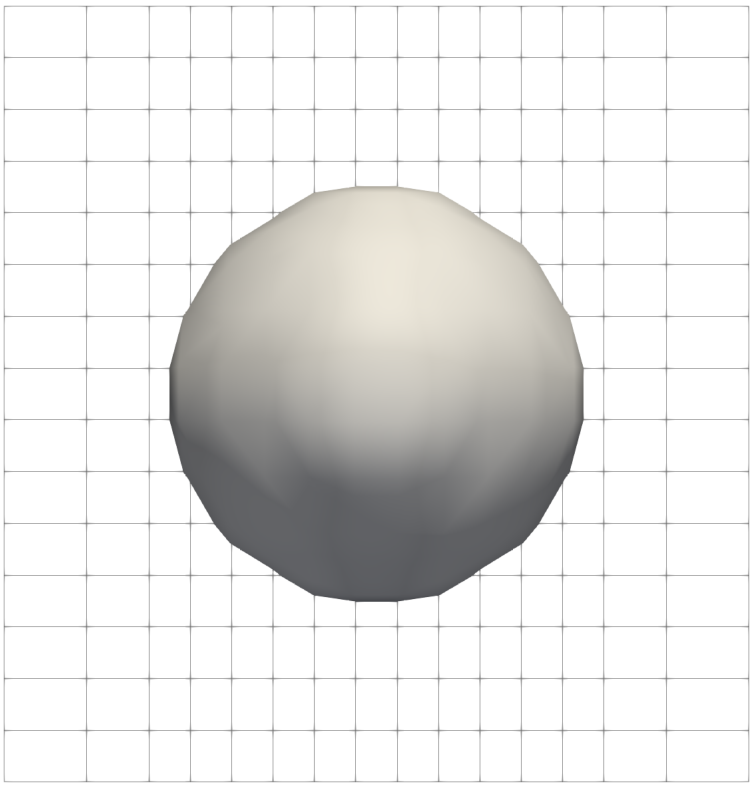

Figure 5: Velocity vectors plotted on the xy-plane at the center of the cubic cavity with a $16 \times 16 \times 16$ grid.

1.2 Future work

- Implement model equations for vortex-induced vibration.