Progress Report

Syed Ahmad Raza

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1 Validation of 3D Navier-Stokes Solver using QUICK scheme

A three-dimensional finite volume Navier-Stokes solver was coded in C++. Results were obtained for three-dimensional lid-driven cubic cavity flowusing QUICK scheme with Re = 100 for a 41×41×41 grid size. The pressure contours and velocity vectors are shown below.

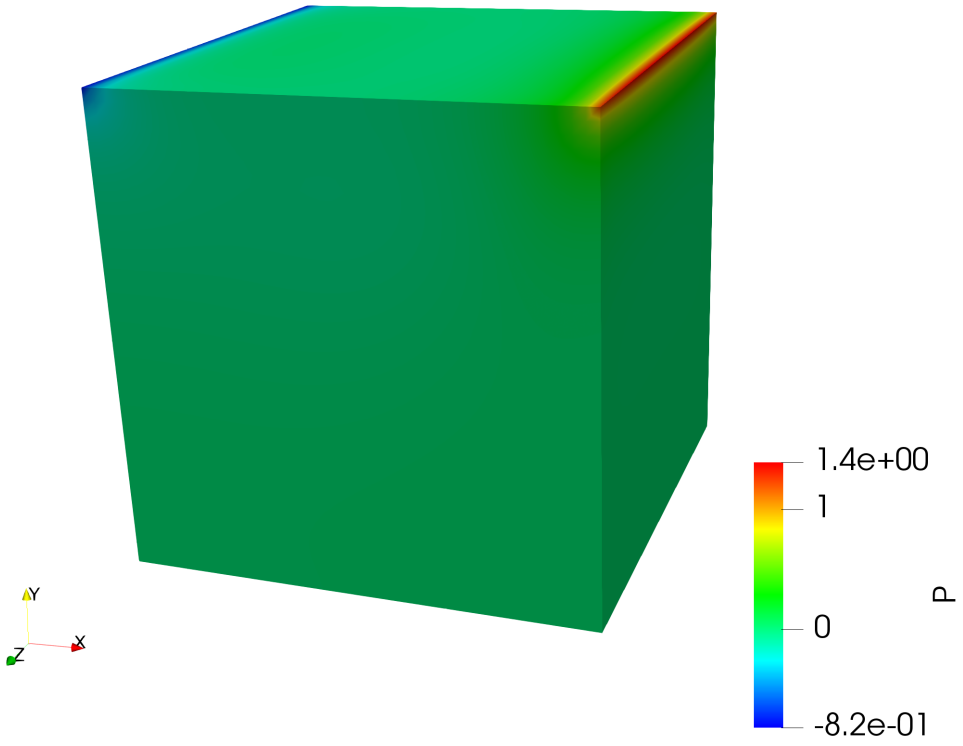

Figure 1: Pressure contours for three-dimensional cavity flow

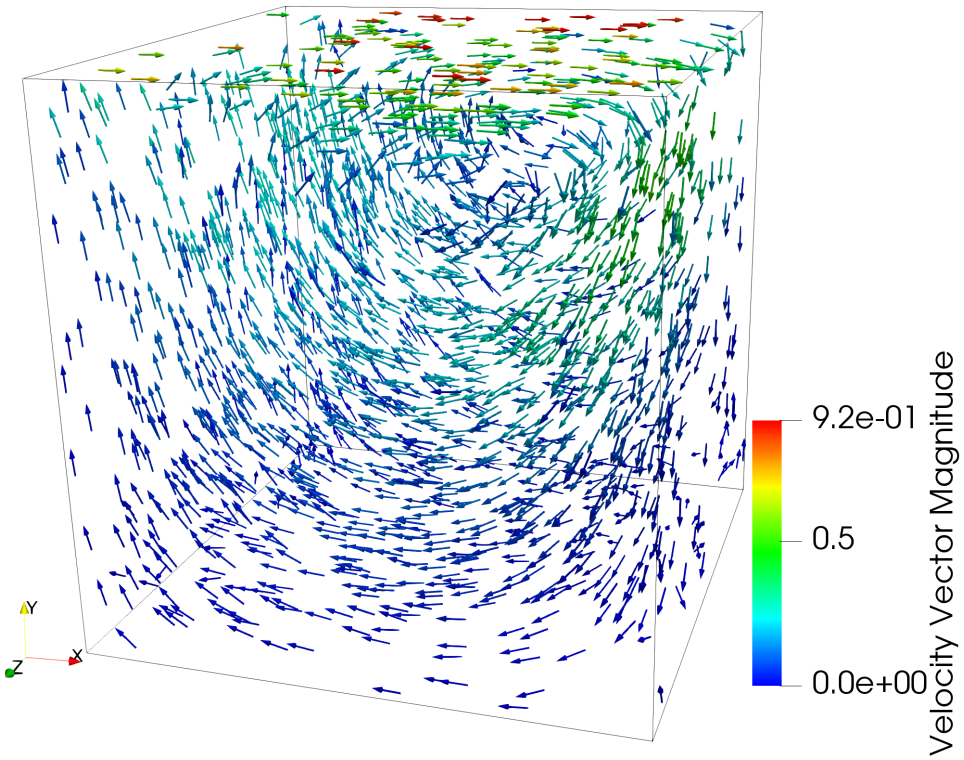

Figure 2: Velocity vectors for three-dimensional cavity flow

1.1 Comparison with published literature

The simulation results at Re = 100 have been compared with the published results of Ku et al. [1] for three-dimensional cubic cavity flow and Ghia et al. [2] for two-dimensional square cavity flow. The figures below represent the comparison of x-direction velocity u on the vertical centerline and y-direction velocity v on the horizontal centerline of the cubic cavity.

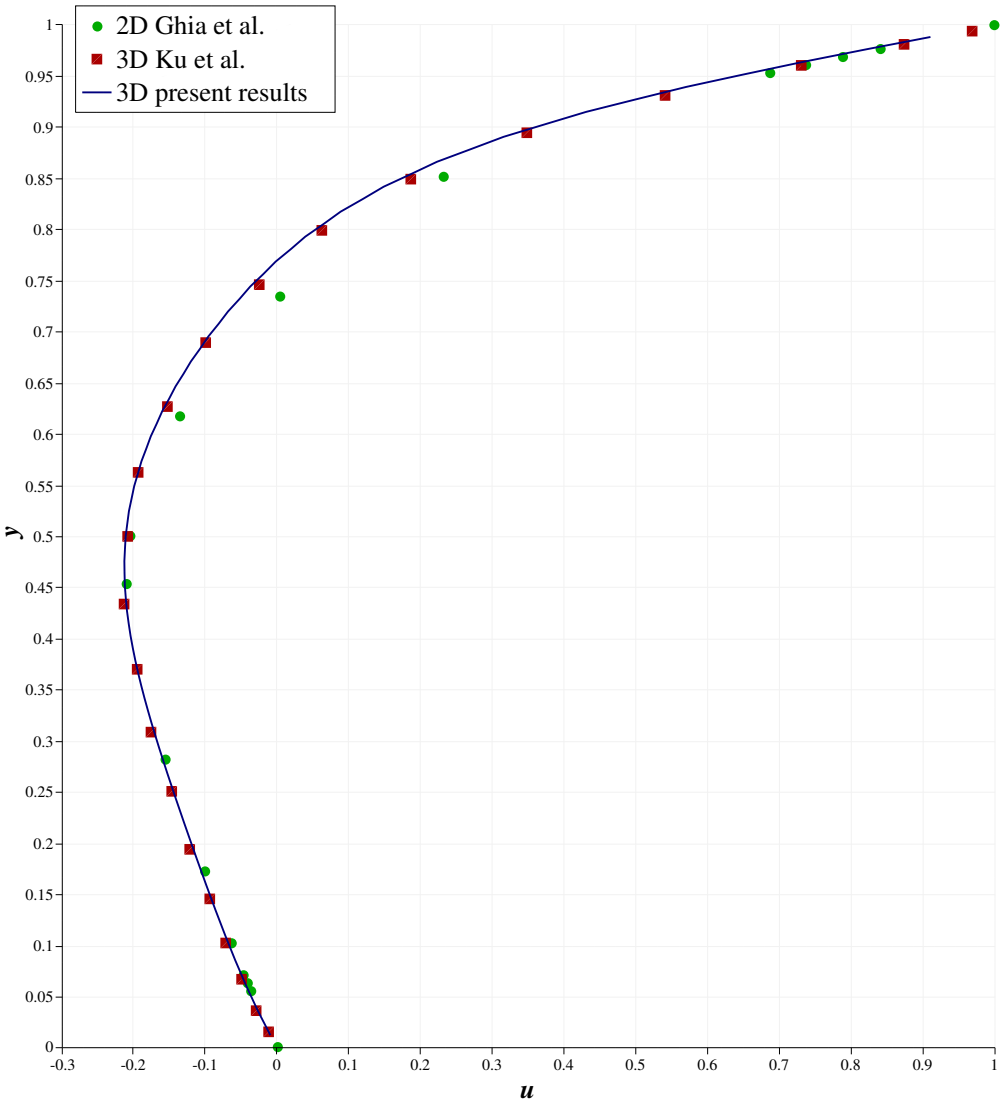

Figure 3: u-velocity profile on the vertical centerline in cubic cavity (at the center of z-axis).

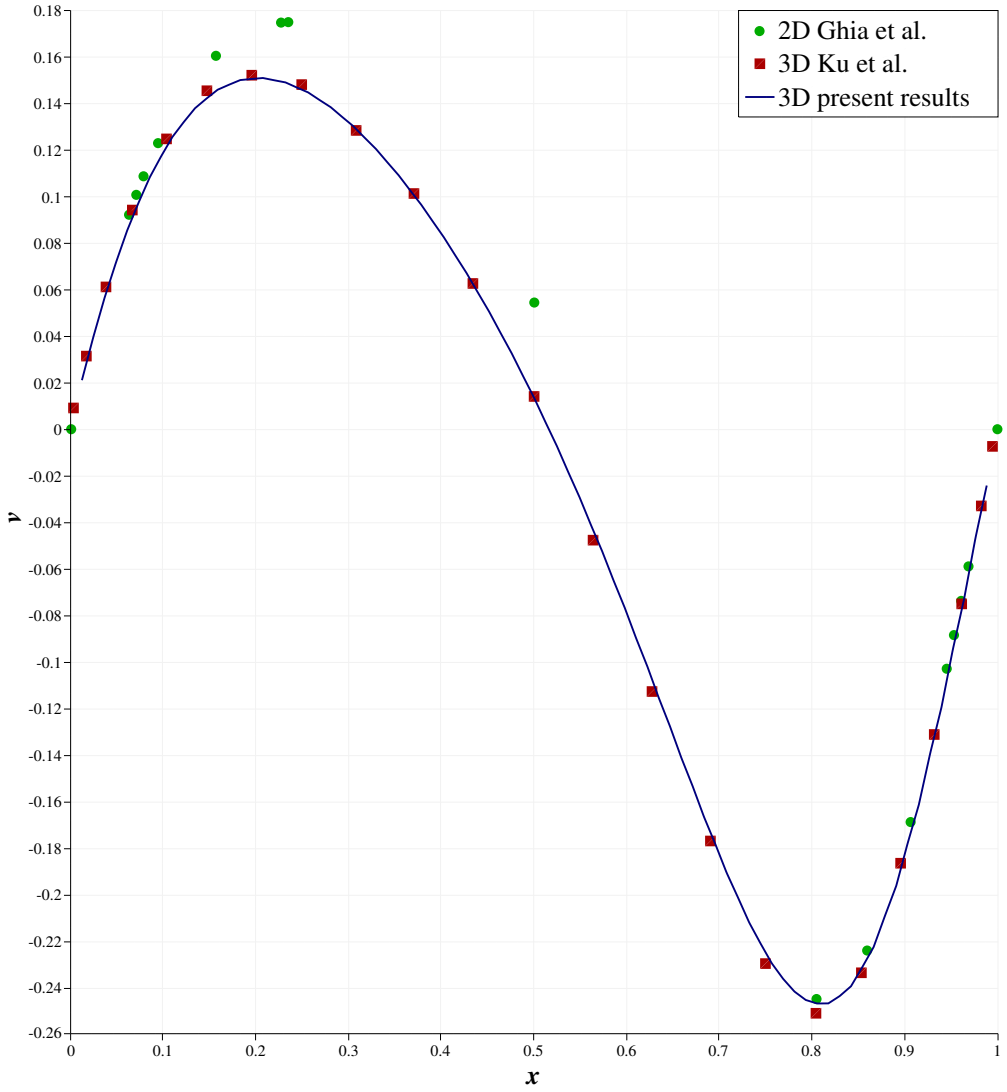

Figure 4: v-velocity profile on the horizontal centerline in cubic cavity (at the center of z-axis).

The results of the developed solver are in very good agreement with the three-dimensional results of Ku et al [1]. The differences with two-dimensional flow are apparent due to the effect of three-dimensional boundary conditions.

1.2 Future tasks

1. Obtain and compare results at Re = 400 and Re = 1000.

2. Convert the 2D and 3D code for use with parallel computing using OpenMP.

References

[1] Hwar C. Ku, Richard S. Hirsh, and Thomas D. Taylor. A pseudospectral method for solution of the three-dimensional incompressible navier-stokes equations. *J. Comput. Phys.*, 70(2):439–462, June 1987.

[2] U Ghia, K.N Ghia, and C.T Shin. High-re solutions for incompressible flow using the navier-stokes equations and a multigrid method. *Journal of Computational Physics*, 48(3):387 – 411, 1982.