Members

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Optimizing Hydrodynamic Simulations of Quantum Fluids

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**Introduction**

Here we will talk briefly summarizing the progress we have made.

**Progress**

We have succeeded in implementing the following things:

1. **Single-Core Optimization:** runs faster! Here is a plot of the speedup and efficiency for the benchmark cases!
2. **OpenMP:** We have succeeded (?) in developing an OpenMP version of the 2D code that runs faster. Here is a plot of the speedup and efficiency for the benchmark cases!
3. **MPI:** We have thought about domain decomposition and Aniq will talk about that.

MPI Implementation for 2D code is roughly half-way completed, but needs extensive testing. We have been able to accomplish the following so far:

1. Create 2D Cartesian Topology for any given number of even processors, and determine their local boundaries including halo points.
2. Adjust boundary points to wrap around periodically.
3. Execute initialize function correctly on each processor and call the main computation task

Following tasks remain to be completed:

1. Execute main computation task correctly on each processor
2. Implement parallel writing using HDF5.

3) Implement the code for the 3D lattice.

All the code has been pushed to git hub and can be reviewed as a proof of progress.

1. **Data Handling:** We have implemented HDF5.
2. **Profiling:** We have done some profiling on the original code, the optimized serial code, and the OpenMP code and here are some figures!

**Problem Size**

The physical case for the 2D benchmark is a lattice size of 1001 by 1001 with a standard deviation of 200 and 1000 time steps. The physical case for the 3D benchmark will be a lattice size of 251 by 251 by 251 with a standard deviation of 50 and 500 time steps. We have run the following accuracy and performance tests of weak scaling for the 2D case:

|  |  |  |  |
| --- | --- | --- | --- |
| Nx | Ny | Standard Deviation | Number of Time steps |
| 251 | 251 | 50 | 250 |
| 501 | 501 | 100 | 250 |
| 1001 | 1001 | 200 | 250 |

The accuracy and performance tests for the 3D case will be

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nx | Ny | Nz | Standard Deviation | Number of Time steps |
| 125 | 125 | 125 | 25 | 250 |
| 251 | 251 | 251 | 50 | 250 |
| 501 | 501 | 501 | 100 | 250 |

**References**

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3. Latt, Jonas. “Hydrodynamic Limit of the Lattice Boltzmann Equations.” *Thesis, University of Geneva*. 2007.
4. Succi, Sauro. “The Lattice Boltzmann Equation for Fluid Dynamics and Beyond.” *Oxford University Press .* 2001.