

1. Assignment 3: GPU-Accelerated 2D Poisson Equation Solver

1.1 Performance Analysis

We implement a GPU-accelerated solver for the 2D Poisson equation using CUDA. Our tests implement a grid size of 400 and the graphical output is shown below.

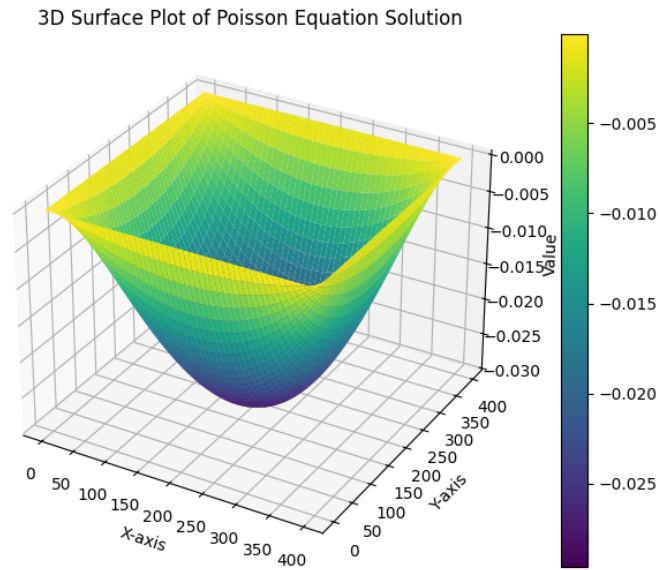
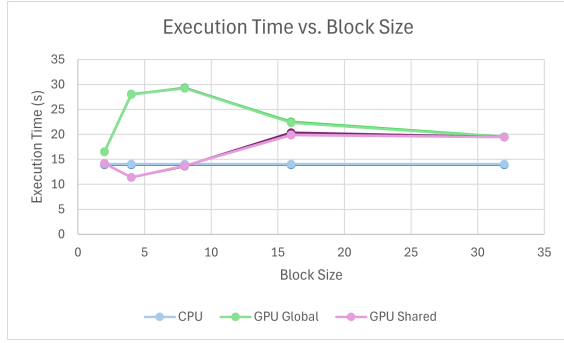


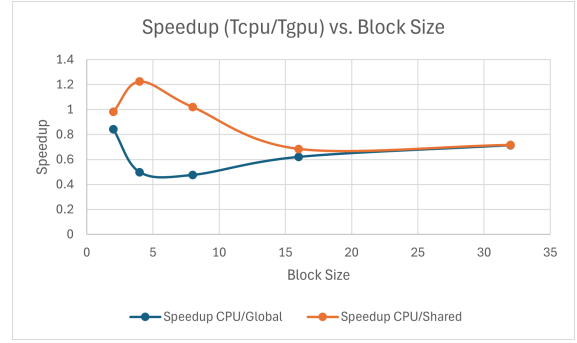
Figure 1: Poisson Equation Solution

We compare the execution time of CPU and GPU implementations. The results are shown in Figure 2, showing execution times and speedups.

Depending on the block size, the shared memory implementation outperforms the CPU version. We observe that by increasing the grid size for the Poisson Equation solution, the GPU's performance gradually surpasses that of the CPU implementation (tested for grid sizes from 50 to 800). However, our tests were limited and could not support larger grid sizes due to a lack of convergence (even when significantly increasing max iterations or reasonably tuning tolerance).



(a) Execution Time Analysis



(b) Speedup Analysis

Figure 2: Performance of CPU vs. GPU

We suspect that at even higher grid sizes, the GPU would consistently outperform the CPU. This is because the benefits of parallelization eventually outweigh the kernel launch overhead, or memory overhead associated with the device/GPU.