Parallel Implementation of Conjugate Gradient Method for Discrete Poisson Problems

Sahithi Rampalli
The Pennsylvania State University

Abstract

Discrete Poisson Equation is used in various scientific studies such as heat flow, computational fluid dynamics and more. In order to solve the system of linear equation, an iterative solver, Conjugate Gradient (CG) is used. The matrix dimensions can be of the order of 10^5. Hence, the solver has to be made more efficient .

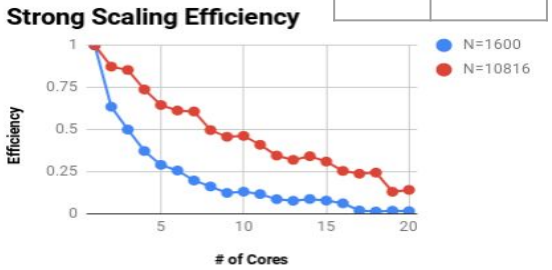
Introduction

Finite difference numerical method is used to discretize the 2-dimensional Poisson equation. The size of the grids on which the equation is applied can go as large as 10s or 100s of 1000s. For such large matrix sizes, it is clearly essential to parallelize and optimize the solvers. Hence, an efficient implementation of CG which can be used in various physical applications is necessary. We show how the C

Direct vs Iterative Solvers

Speedup of Conjugate Gradient method over the direct solver (LU Decomposition) is shown in the table.

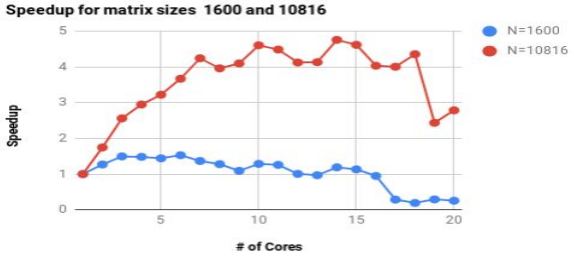
N	Speedup
64	4.8x
256	42.5x
1024	231x



Serial vs Parallel Codes

Speedup of Parallel CG with 4 threads over serial CG is shown in the table.

N	Speedup
64	4.8x
256	42.5x
1024	231x



Discussion

- Strong Scaling efficiency decreases with increase in number of cores.
- Speedup is greater for larger matrix sizes with the increase in number of cores.

Conclusion

- For production problem size of 250000 and 1000000, 10-14 cores would be optimal given efficiency is about 0.5.

Contact
Sahithi Rampalli
PSU
svr46@gmail.com:

Acknowledgement

I acknowledge Dr. Adam Lavely, Dr. Christopher Blanton for providing the required resources to make this work happen.
I acknowledge ACI-ICS for providing the required servers.

References

1. https://arxiv.org/abs/1803.03797