7/13/2021

These are initial tests comparing the ACA solver with my old solver that directly fills the entire Z matrix.

**Rectangular Strip (1:5 width:length ratio)**

Compress matrices with 1+ node separation

Default GMRES settings

Number of elements = 640

Old Solver time: 7.004231 seconds (86.14 M allocations: 9.163 GiB, 11.04% gc time)

ACA Solver time: 5.824028 seconds (63.32 M allocations: 6.601 GiB, 9.71% gc time)

Relative l2-norm of error = 1.289785963744035e-5

Displaying ACA Metrics:

Octree Metrics:

Number of elements per node:

Mean = 80.0

Min = 80

Max = 80

Matrix Metrics:

Matrix Rank:

Mean = 7.0

Min = 6

Max = 8

Compression Metrics:

Percentage of Matrices Compressed = 37.5

Compression Ratio = num entries for ACA / (num elements)^2 = 0.690625

Compression ratio \* old solver time = 4.83 seconds

**Rectangular Strip 2 w/ More Elements (1:5 width:length ratio)**

Compress matrices with 1+ node separation

Number of elements = 2560

Old Solver time: 106.815909 seconds (1.32 G allocations: 140.331 GiB, 12.15% gc time)

ACA Solver time: 51.439251 seconds (856.41 M allocations: 91.057 GiB, 8.54% gc time)

Relative l2-norm of error = 1.6827868794517776e-5

Displaying ACA Metrics:

Octree Metrics:

Number of elements per node:

Mean = 320.0

Min = 320

Max = 320

Matrix Metrics:

Matrix Rank:

Mean = 7.625

Min = 6

Max = 9

Compression Metrics:

Percentage of Matrices Compressed = 37.5

Compression Ratio = 0.64287109375

Compression ratio \* old solver time = 68.4 seconds

**Sphere 1 (1m radius)**

Compress matrices with 1+ node separation

Number of elements = 328

Old Solver time: 2.341355 seconds (21.92 M allocations: 2.321 GiB, 9.95% gc time)

ACA Solver time: 3.964776 seconds (35.43 M allocations: 3.636 GiB, 9.28% gc time)

Relative l2-norm of error = 4.249074120541143e-5

Displaying ACA Metrics:

Octree Metrics:

Number of elements per node:

Mean = 5.851851851851852

Min = 1

Max = 9

Matrix Metrics:

Matrix Rank:

Mean = 4.44804655029094

Min = 1

Max = 7

Compression Metrics:

Percentage of Matrices Compressed = 82.51028806584361

Compression Ratio = 1.5508031565454254

Compression ratio \* old solver time = 3.63 seconds

**Sphere 2 w/ More Elements (1m radius)**

Compress matrices with 1+ node separation

Number of elements = 1266

Old Solver time: 23.308423 seconds (324.88 M allocations: 34.589 GiB, 10.14% gc time)

ACA Solver time: 15.702069 seconds (215.66 M allocations: 22.993 GiB, 10.79% gc time)

Relative l2-norm of error = 0.00016960434167485557

Displaying ACA Metrics:

Octree Metrics:

Number of elements per node:

Mean = 22.607142857142858

Min = 2

Max = 33

Matrix Metrics:

Matrix Rank:

Mean = 6.02

Min = 2

Max = 11

Compression Metrics:

Percentage of Matrices Compressed = 82.90816326530613

Compression Ratio = 0.6502405855913189

Compression ratio \* old solver time = 15.15 seconds

**Sphere 3 w/ Even More Elements (1m radius)**

Compress matrices with 1+ node separation

Number of elements = 3788

Old Solver time: 231.260390 seconds (2.86 G allocations: 304.838 GiB, 11.81% gc time)

ACA Solver time: 84.099488 seconds (1.02 G allocations: 109.438 GiB, 11.96% gc time)

Relative l2-norm of error = 0.0003455360433566886

Displaying ACA Metrics:

Octree Metrics:

Number of elements per node:

Mean = 67.64285714285714

Min = 12

Max = 89

Matrix Metrics:

Matrix Rank:

Mean = 6.618846153846154

Min = 4

Max = 12

Compression Metrics:

Percentage of Matrices Compressed = 82.90816326530613

Compression Ratio = 0.3532129611767946

Compression ratio \* old solver time = 80.85 seconds

**Sphere 4 w/ Even Even More Elements (1m radius)**

Compress matrices with 1+ node separation

Number of elements = 8010

Old Solver time: NOT RAN

ACA Solver time: 292.855263 seconds (3.44 G allocations: 366.873 GiB, 12.58% gc time)

Relative l2-norm of error = N/A

Displaying ACA Metrics:

Octree Metrics:

Number of elements per node:

Mean = 143.03571428571428

Min = 24

Max = 186

Matrix Metrics:

Matrix Rank:

Mean = 6.725769230769231

Min = 4

Max = 13

Compression Metrics:

Percentage of Matrices Compressed = 82.90816326530613

Compression Ratio = 0.26735093929093

Conclusions:

* The ACA solver is faster for relatively small meshes
* Error seems to increase with number of elements when input parameters are constant
* Compression ratio times the old solver time is approximately the run time of the ACA solver for the sphere. For the plate, it trends correctly, but is not as accurate of a prediction of ACA solver time.

Nest Steps:

* Scaling Study
  + Use Sphere
  + Run 5 iterations with the direct solver and ACA solver
  + Do one study with 3 octree levels
  + Do a second study with 4 octree levels
  + This will reveal where the breakeven point is between algorithms as well as the breakeven point of when it is best to use more octree levels (hopefully).