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Feedback on the Utilization of MUMPS

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Use of MUMPS

- Use MUMPS since 2008 in production
- Accuracy, robustness, efficiency (In- and Out-of-core)
- Memory (resource) consumption information
- Support
- Structural Mechanics (FEM), NVH, Stamping, Casting, …

Acoustic Impedance

$Z = C^T A^{-1} C$, $A = A^T$ N-by-N complex,

C real (M + Ms + Mf) x (Ns + Nf)

With N ~ M >> Ms, Mf, Ns + Nf

For many frequencies.

0	C^T_{ss}	0
0	0	C^T_{ff}

A^{-1}

0	0
C_{ss}	0
0	C_{ff}

Acoustic Impedance

N = M + Ms + Mf	Ms + Mf	Ns + Nf
223.972	2.309 + 64.567	141+120
338.838	30.423 + 46.265	3.358 + 249
1.876.246	77.252 + 41.404	3.358 + 249

	Ns	Nf
M	0	0
Ms	C_{ss}	0
Mf	0	C_{ff}

Method 1

Solve $A X = C$,

$Z = C^T X$

$Z_{ss} = C^T_{ss} \; X_{ss}$
$Z_{ff} = C^T_{ff} \; X_{ff}$

$Z_{sf} = C^T_{ss} \; X_{sf}$
or
$Z_{fs} = C^T_{ff} \; X_{fs}$

$$A \begin{bmatrix} X_{us} & X_{uf} \\ X_{ss} & X_{sf} \\ X_{fs} & X_{ff} \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ C_{ss} & 0 \\ 0 & C_{ff} \end{bmatrix}$$

$$\begin{bmatrix} 0 & C^T_{ss} & 0 \\ 0 & 0 & C^T_{ff} \end{bmatrix} \begin{bmatrix} Z_{ss} & Z_{sf} \\ Z_{fs} & Z_{ff} \end{bmatrix}$$

Method 2

Schur complement S

$S = 0 - C^T A^{-1} C = -Z$

[Scale A first]*

A			0	0
			C_{ss}	0
			0	C_{ff}
0	C^T_{ss}	0	0	0
0	0	C^T_{ff}	0	0

Performance comparison

N = 298.562, Ns + Nf = 4032 (63 * 64)

Method 1 (s)	1	2	4	8
Symbolic fact	6	6	6	6
Numeric fact	208	114	70	44
Solve	1923	1204	650	492
Total	2137	1324	726	542

Method 2 (s)	1
Schur	2120

Wish list, conclusions

- Parallel ordering efficiency
  - On large problems, Metis is a bottleneck, and ParMetis or PT-Scotch orderings are not as good: What you win in the parallel ordering is lost in the numerical factorization.
- Thread Parallelism

- Overall, very happy / satisfied users.


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