

Contents

Preface	ix
List of Contributors	xiii
1 Overcoming Engineering Design Time and Distance Hurdles Via High-Performance Computing	
E. J. Plaskacz	1
1.1 Introduction	1
1.2 Overcoming time hurdles	2
1.3 Overcoming distance hurdles	37
Acknowledgements	43
References	44
2 Solving Large-Scale Structural Problems on Parallel Computers using Domain Decomposition Techniques	
P. Le Tallec and M. Vidrascu	49
2.1 Introduction	49
2.2 A model problem	50
2.3 A basic domain decomposition algorithm	52
2.4 Construction of the precondition	55
2.5 Abstract convergence theory	58
2.6 Implementation issues	64
2.7 Application and numerical results	67
2.8 Concluding remarks	80
References	82
3 Domain Decomposition Techniques for Computational Structural Mechanics	
M. Papadrakakis	87
3.1 Introduction	87
3.2 The global subdomain implementation (GSI)	89
3.3 The primal subdomain implementation (PSI) on the interface	104
3.4 The dual subdomain implementation (DSI) on the interface	113
3.5 The solution of linear systems with multiple right-hand sides	122
3.6 Solving topology optimization and sensitivity analysis problems	125

3.7	Solving stochastic finite element analysis problems with Monte Carlo simulation	135
	Acknowledgements	140
	References	140
4	Parallel Adaptive Multigrid Methods for Elasticity, Plasticity and Eigenvalue Problems	
	I. D. Parsons	143
4.1	Introduction	143
4.2	Solution of linear matrix equations	144
4.3	Algorithm behaviour and implementation	149
4.4	Treatment of material nonlinearities	158
4.5	Algorithms for eigenvalue problems	163
4.6	Adaptive multigrid methods	172
4.7	Concluding remarks	178
	Acknowledgements	179
	References	179
5	Accuracy and Stability of Multi-Time Step Integration Schemes in Explicit Structural Dynamic Analysis	
	S. Gupta and M. Ramirez	181
5.1.	Introduction	181
5.2	Multi-time step algorithm	184
5.3	Definition of error terms	185
5.4	Numerical experimentation	186
5.5	Instabilities in multi-time step schemes	198
5.6	Frequency domain analysis	199
5.7	Dissipative algorithms, a family of methods	200
5.8	Numerical examples	208
5.9	Parallel implementation	210
5.9	Conclusion	214
	References	215
6	Krylov Subspace Methods on Parallel Computers	
	Y. Saad	219
6.1	Introduction	219
6.2	Krylov subspace methods	220
6.3	Parallel implementations	223
6.4	Data-parallel preconditions	225
6.5	Distributed sparse matrices	231
6.6	Conclusion	238
	References	239

7	Parallel Distributed Solution of Coupled Nonlinear Dynamic Aeroelastic Response Problems	
	C. Farhat	243
	7.1 Introduction	243
	7.2 Geometric conservation laws	250
	7.3 A family of staggered solution procedures	261
	7.4 The flow solver	273
	7.5 The structural dynamics analyzer	276
	7.6 Non-matching interface boundaries	279
	7.7 The mesh motion solver	282
	7.8 A unified parallelization strategy	283
	7.9 Applications and performance results	284
	7.10 Conclusions	297
	Acknowledgements	298
	References	298
8	Finite Element and Active Element Placement Techniques for Control Structure Interaction Applications	
	R. C. Shieh	303
	8.1 General	303
	8.2 Formulations of transient response problems and FE method-based MPP computational procedures	305
	8.3 Placement optimization techniques of active elements (sensors/actuators) for static structural shape control	323
	8.4 Concluding remarks	331
	References	332
9	Structural Optimization Based on Evolution Strategies	
	G. Thierauf and J. Cai	335
	9.1 Introduction	335
	9.2 The original evolution strategies	336
	9.3 The modified evolution strategies	339
	9.4 Parallelization of the M-ES	341
	9.5 The two level parallelization	346
	9.6 Examples	349
	Summary	359
	Acknowledgements	359
	References	360
10	High Performance Computing Techniques for Flow Simulations	
	T. Tezduyar, S. Aliabadi, M. Behr, A. Johnson, V. Kalro and M. Litke	363
	10.1 Introduction	363
	10.2 Governing equations of compressible and incompressible flows	365
	10.3 Stabilized finite element formulations	367
	10.4 3D mesh generation for flow simulations with complex geometries	369

10.5	3D mesh update techniques for flow problems involving moving boundaries and interfaces	370
10.6	Interactive solution strategies for large-scale computations	372
10.7	Parallel computing	374
10.8	Examples	377
10.9	Concluding remarks	382
	Acknowledgements	383
	References	383
11	Advanced Computational Technology for Product Design R. K. Agarwal and V. Shankar	399
11.1	Abstract	399
11.2	Introduction	399
11.3	Computational framework	401
11.4	Implementation on MIMD computers	405
11.5	Computational aerospace applications	406
11.6	Computational commercial applications	420
11.7	Conclusions	429
	Acknowledgements	429
	References	429
12	Multi-Color Neural Network with Feedback Mechanism for Parallel Finite Element Fluid Analysis H. Okuda and G. Yagawa	431
12.1	Introduction	431
12.2	Review of neural network application	434
12.3	Basis of neural network	435
12.4	Multi-color neural network solver for the Poisson equation	438
12.5	Applications to incompressible flow analysis	443
12.6	Concluding remarks	453
	Acknowledgements	454
	References	454
13	Parallel Automatic Mesh Generation and Adaptive Mesh Control M. S. Shephard, J. E. Flaherty, H. L. de Cougny, C. L. Botasso and C. Ozturan	459
13.1	Introduction	459
13.2	Parallel control of evolving meshes	460
13.3	Parallel automatic mesh generation	473
13.4	Parallel mesh enrichment	480
13.5	Parallel adaptive analysis	485
13.6	Closing remarks	491
	Acknowledgements	491
	References	491
	Index	495