Matrix Pencil Computations in Computer-Aided Control System Design: Theory, Algorithms and Software Tools

Publications 2002–2009 within the SSF project

This version: 2010–03–29

The following list of publications (scientific journal articles, refereed conference proceedings, Theses, and technical reports) is structured by subprojects. Within each subproject, the publications are listed in alphabetical order by authors. Except for a few cases, the authors of a publication are listed alphabetically, which is the tradition we typically follow. Notice that several publications fit more than one subproject and are therefore listed under each of them.

Algorithms and Tools for Computing Structural Information of Matrix Pencils and Descriptor-Type Systems under Perturbations

[1] E. Elmroth, P. Johansson, S. Johansson, and B. Kågström. Orbit and Bundle Stratification of Controllability and Observability Matrix Pairs in StratiGraph. In *Proc. Sixteenth International Symposium on Mathematical Theory of Networks and Systems (MTNS-2004)*, 10 pages (CD-ROM), 2004.

[2] E. Elmroth, P. Johansson, and B. Kågström. Bounds for the Distance Between Nearby Jordan and Kronecker Structures in a Closure Hierarchy. *Journal of Mathematical Sciences*, 112(6):1765–1779, 2003.

[3] E. Elmroth, S. Johansson, and B. Kågström. Stratification of Controllability and Observability Pairs - Theory and Use in Applications. *SIAM J. Matrix Anal. Appl.*, 31(2):203–226, 2009.

[4] Pedher Johansson. StratiGraph user's guide. Technical Report UMINF 03.21, Umeå University, Sweden, December 2003.

[5] Pedher Johansson. Matrix canonical structure toolbox. Technical Report UMINF 06.15, Umeå University, Sweden, April 2006.

[6] Pedher Johansson. StratiGraph developers's guide. Technical Report UMINF 06.14, Umeå University, Sweden, April 2006.

[7] Pedher Johansson. StratiGraph software design and algorithms. Technical Report UMINF 06.16, Umeå University, Sweden, April 2006.

[8] Pedher Johansson. Software Tools for Matrix Canonical Computations and Web-Based Software Library Environments. *PhD Thesis* UMINF-06.30, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, November, 2006.

[9] S. Johansson. Canonical forms and stratification of orbits and bundles of system pencils. Technical Report UMINF 05.16, Department of Computing Science, Umeå University, Sweden, 2005.

[10] S. Johansson. Reviewing the closure hierarchy of orbits and bundles of system pencils and their canonical forms. Technical Report UMINF 09.02, Department of Computing Science, Umeå University, Sweden, 2009.

[11] S. Johansson. *Tools for Control System Design — Stratification of Matrix Pairs and Periodic Riccati Differential Equation Solvers.* Ph.D. Thesis, Report UMINF 09.04, Department of Computing Science, Umeå University, Sweden, March 2009. ISBN 978-91-7264-733-6.

[12] Stefan Johansson. Stratification of Matrix Pencils in Systems and Control: Theory and Algorithms. *PhLicentiate Thesis* UMINF-05.17, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, May, 2005.

[13] B. Kågström and D. Kressner. Multishift Variants of the QZ Algorithm with Aggressive Early Deflation. *SIAM J. Matrix Anal. Appl.*, 29(1):199–227, 2006.

[14] B. Kågström, D. Kressner, E. Quintana-Orti, and G. Quintana-Orti. Blocked Algorithms for the Reduction to Hessenberg-Triangular Form Revisited. *BIT Numerical Mathematics*, 48(1):563–584, 2008.

[15] M. Karow and D. Kressner. On the structured distance to uncontrollability. *Systems Control Lett.*, 58(2):128–132, 2009.

[16] D. Kressner. Block algorithms for reordering standard and generalized Schur forms. *ACM Trans. Math. Software*, 32(4):521–532, 2006.

[17] D. Kressner. Structured condition numbers for invariant subspaces. *SIAM J. Matrix Anal. Appl.*, 28(2):326–347, 2007.

[18] D. Kressner. The effect of aggressive early deflation on the convergence of the QR algorithm. *SIAM J. Matrix Anal. Appl.*, 30(2):805–821, 2008.

[19] D. Kressner, M. J. Peláez, and J. Moro. Structured Hölder condition numbers for multiple eigenvalues. *SIAM J. Matrix Anal. Appl.*, 31(1):175–201, 2009.

[20] Ji-guang Sun. Condition numbers of spectral projections. Report UMINF-02.18, ISSN-0348-0542, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, 2002.

[21] A. Varga. Computation of Kronecker-like forms of periodic matrix pairs. In *Proc. of MTNS'04, Leuven, Belgium*, pages 176–181, 2004.

Design and Analysis of Periodic Systems

[1] P. Andersson, R. Granat, and B. Kågström. Parallel Algorithms for Triangular Periodic Sylvester-type Matrix Equations. In E. Luque, T. Margalef, and D. Benítez, editors, *Euro-Par 2008 Parallel Processing – 14th International Euro-Par Conference*, volume LNCS 5168 of *Lecture Notes in Computer Science*, pages 780–789. Springer-Verlag, 2008.

[2] R. Granat and B. Kågström. Direct Eigenvalue Reordering in a Product of Matrices in Extended Periodic Schur Form. *SIAM J. Matrix Anal. Appl.*, 28(1):285–300, 2006.

[3] R. Granat, B. Kågström, and D. Kressner. Reordering the Eigenvalues of a Periodic Matrix Pair with Applications in Control. In *Proc. 2006 IEEE Conference on Computer Aided Control Systems Design (CACSD)*, pages 25–30, 2006.

[4] R. Granat, B. Kågström, and D. Kressner. Computing Periodic Deflating Subspaces Associated with a Specified Set of Eigenvalues. *BIT Numerical Mathematics*, 47:763–791, 2007.

[5] R. Granat, B. Kågström, and D. Kressner. MATLAB Tools for Solving Periodic Eigenvalue Problems. In *Proc. 3rd IFAC Workshop PSYCO'07*, 2007.

[6] Robert Granat. Algorithms and Library Software for Periodic and Parallel Eigenvalue Reordering and Sylvester-Type Matrix Equations with Condition Estimations. *PhD Thesis* UMINF-07.21, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, November, 2007.

[7] S. Gusev, S. Johansson, B. Kågström, A. Shiriaev, and A. Varga. A numerical evaluation of solvers for the periodic Riccati differential equation. *BIT Numerical Mathematics*, 2010. (accepted).

[8] S. Johansson. *Tools for Control System Design — Stratification of Matrix Pairs and Periodic Riccati Differential Equation Solvers.* Ph.D. Thesis, Report UMINF 09.04, Department of Computing Science, Umeå University, Sweden, March 2009. ISBN 978-91-7264-733-6.

[9] S. Johansson, B. Kågström, A. Shiriaev, and A. Varga. Comparing one-shot and multi-shot methods for solving periodic Riccati differential equations. In *Proc. 3rd IFAC Workshop PSYCO'07*, 2007.

[10] Ji-guang Sun. Backward perturbation analysis of the periodic discrete-time algebraic Riccati equation. *SIAM J. Anal. Appl.*, 26:1–19, 2004.

[11] Ji-guang Sun. Perturbation Bounds for Subspaces Associated with Periodic Eigenproblems. *Taiwanese Journal of Mathematics*, 9(1):17–38, 2005.

[12] A. Varga. Computation of fault detection filters for periodic systems. In *Proc. of 43rd IEEE Conference on Decision and Control*, Bahamas, December 2004.

[13] A. Varga. Computation of generalized inverses of periodic systems. In *Proc. of CDC'04, Paradise Island, Bahamas*, pages 176–181, 2004.

[14] A. Varga. Computation of Kronecker-like forms of periodic matrix pairs. In *Proc. of MTNS'04, Leuven, Belgium*, pages 176–181, 2004.

[15] A. Varga. On solving discrete-time periodic Riccati equations. In *Prepr. of IFAC 2005 World Congress, Prague, Czech Republic*, pages 176–181, 2005.

[16] A. Varga. On solving periodic differential matrix equations with applications to periodic system norms computation. In *(submitted to CDC 2005, Seville, Spain)*, 2005.

[17] A. Varga. Computation of L-infinity norm of linear discrete-time periodic systems. In *Mathematical Theory of Networks and Systems, MTNS2006*, Kyoto, Japan, 2006.

[18] A. Varga. On computing frequency-responses of periodic systems. In *Mathematical Theory of Networks and Systems, MTNS2006*, Kyoto, Japan, 2006.

[19] A. Varga. On computing minimal dynamic covers for periodic systems. In *Proc. of European Control Conference, ECC'07*, Kos, Greece, 2007.

[20] A. Varga. On computing minimal realizations of periodic descriptor systems. In *Proc. 3rd IFAC Workshop on Periodic Systems,* PSYCO'07, Russia, 2007.

[21] A. Varga. An overview of recent developments in computational methods for periodic systems. In *Proc. 3rd IFAC Workshop on Periodic Systems, PSYCO'07*, St. Petersburg, Russia, 2007.

[22] A. Varga. On solving periodic Riccati equations. *Numerical Linear Algebra with Applications*, 15(9):809–835, 2008.

[23] A. Varga and P. Van Dooren. Computing the zeros of periodic descriptor systems. *Sys. Control Lett.*, 50:371–381, 2003.

Multibody Simulations and Contact Problems

[1] S. Gusev, S. Johansson, B. Kågström, A. Shiriaev, and A. Varga. A numerical evaluation of solvers for the periodic Riccati differential equation. *BIT Numerical Mathematics*, 2010. (accepted).

[2] S. Johansson, B. Kågström, A. Shiriaev, and A. Varga. Comparing one-shot and multi-shot methods for solving periodic Riccati differential equations. In *Proc. 3rd IFAC Workshop PSYCO'07*, 2007.

[3] C. Lacoursière. A regularized time stepper for multibody systems. In J. Sporring, K. Erleben, and H. Dohlmann, editors, *PDE Methods in Computer Graphics*. Charles River Media, 2005.

[4] C. Lacoursière. Regularized, stabilized, variational methods for multibodies. In Dag Fritzson Peter Bunus and Claus Führer, editors, *The 48th Scandinavian Conference on Simulation and Modeling (SIMS 2007), 30-31 October, 2007, Göteborg (Särö), Sweden*, Linköping Electronic Conference Proceedings, pages 40–48. Linköping University Electronic Press, December 2007.

[5] Claude Lacoursiere. Ghosts and Machines: Regularized Variational Methods and Interactive Simulations of Multibodies with Dry Frictionoal Contacts. *PhD Thesis* UMINF-07.06, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, June, 2007.

[6] M. Servin and C. Lacoursière. Massless cable for real-time simulation. *Computer Graphics Forum*, 26(2):172–184, 2007.

[7] M. Servin and C. Lacoursière. Rigid body cable for virtual environments. *IEEE Transactions on Visualization*, 14(4):783–796, 2008.

[8] M. Servin, C. Lacoursière, and N. Melin. Interactive simulation of elastic deformable materials. In *Proceedings of SIGRAD Conference 2006 in Skövde, Sweden*, pages 22–32. Linköping University Electronic Press, Linköping, 2006.

Rank-Deficient and Constrained Least Squares Problems

[1] J. Eriksson and M. Gulliksson. Local results for the gauss-newton method on constrained rank-deficient nonlinear least squares. *Journal of Math. Comp.*, 73:1865–1883, 2004.

[2] J. Eriksson, M. Gulliksson, I. Söderqvist, and P-Å. Wedin. Regularization methods for uniformly rank-deficient nonlinear least-squares problems. *Journal of Optimization Theory and Applications (JOTA)*, 127(1):1–26, 2005.

[3] N. Naik, R. Beatson, J. Eriksson, and E. van Houten. An implicit radial basis function based reconstruction approach to electromagnetic shape tomography. *Inverse Problems*, 25, 2009.

[4] N. Naik, J. Eriksson, P. de Groen, and H. Sahli. A nonlinear iterative reconstruction and analysis approach to shape-based approximate electromagnetic tomography. *IEEE Transaction on Geoscience and Remote Sensing*, 46:1558 – 1574, 2008.

[5] T. Viklands. *Algorithms for the Weighted Orthogonal Procrustes Problem and other Least Squares Problems*. Ph.D. Thesis, Report UMINF 06.10, Department of Computing Science, Umeå University, Sweden, April 2006. ISBN 13 978-91-7264-333-8.

[6] T. Viklands. On global minimization of weighted orthogonal Procrustes problems. Technical Report UMINF 06.09, Department of Computing Science, Umeå University, Sweden, 2006.

[7] T. Viklands. On the number of minima to weighted orthogonal Procrustes problems. Technical Report UMINF 06.08, Department of Computing Science, Umeå University, Sweden, 2006.

[8] P.Å. Wedin and T. Viklands. Algorithms for 3-dimensional weighted orthogonal Procrustes problems. Technical Report UMINF 06.06, Department of Computing Science, Umeå University, Sweden, 2006.

[9] P.Å. Wedin and T. Viklands. Algorithms for linear least squares problems on the Stiefel manifold. Technical Report UMINF 06.07, Department of Computing Science, Umeå University, Sweden, 2006.

Perturbation Analysis, Condition Estimation and Reliable Error Bounds

[1] E. Elmroth, P. Johansson, S. Johansson, and B. Kågström. Orbit and Bundle Stratification of Controllability and Observability Matrix Pairs in StratiGraph. In *Proc. Sixteenth International Symposium on Mathematical Theory of Networks and Systems (MTNS-2004)*, 10 pages (CD-ROM), 2004.

[2] E. Elmroth, P. Johansson, and B. Kågström. Bounds for the Distance Between Nearby Jordan and Kronecker Structures in a Closure Hierarchy. *Journal of Mathematical Sciences*, 112(6):1765–1779, 2003.

[3] E. Elmroth, S. Johansson, and B. Kågström. Stratification of Controllability and Observability Pairs - Theory and Use in Applications. *SIAM J. Matrix Anal. Appl.*, 31(2):203–226, 2009.

[4] R. Granat and B. Kågström. Algorithm XXX: The SCASY software library – parallel solvers for Sylvester-type matrix equations with applications in condition estimation, Part II. *ACM Trans. Math. Software* (accepted), February 2010.

[5] R. Granat and B. Kågström. Parallel solvers for Sylvester-type matrix equations with applications in condition estimation, Part I: Theory and algorithms. February 2010. *ACM Trans. Math. Software* (accepted).

[6] R. Granat and B. Kågström. Parallel Solvers for Sylvester-type Matrix Equations with Applications in Condition Estimation, Part I: Theory and Algorithms. *ACM Trans. Math. Software* (submitted), July, 2007 (Also as Report UMINF-07.15).

[7] Robert Granat. Algorithms and Library Software for Periodic and Parallel Eigenvalue Reordering and Sylvester-Type Matrix Equations with Condition Estimations. *PhD Thesis* UMINF-07.21, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, November, 2007.

[8] Pedher Johansson. Matrix canonical structure toolbox. Technical Report UMINF 06.15, Umeå University, Sweden, April 2006.

[9] S. Johansson. Reviewing the closure hierarchy of orbits and bundles of system pencils and their canonical forms. Technical Report UMINF 09.02, Department of Computing Science, Umeå University, Sweden, 2009.

[10] Stefan Johansson. Stratification of Matrix Pencils in Systems and Control: Theory and Algorithms. *PhLicentiate Thesis* UMINF-05.17, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, May, 2005.

[11] M. Karow and D. Kressner. On the structured distance to uncontrollability. *Systems Control Lett.*, 58(2):128–132, 2009.

[12] D. Kressner. Structured condition numbers for invariant subspaces. *SIAM J. Matrix Anal. Appl.*, 28(2):326–347, 2007.

[13] D. Kressner. The effect of aggressive early deflation on the convergence of the QR algorithm. *SIAM J. Matrix Anal. Appl.*, 30(2):805–821, 2008.

[14] D. Kressner, M. J. Peláez, and J. Moro. Structured Hölder condition numbers for multiple eigenvalues. *SIAM J. Matrix Anal. Appl.*, 31(1):175–201, 2009.

[15] Ji-guang Sun. Condition numbers of spectral projections. Report UMINF-02.18, ISSN-0348-0542, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, 2002.

[16] Ji-guang Sun. A note on perturbation expansions for small singular values. Report UMINF-03.07, ISSN-0348-0542, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, 2003.

[17] Ji-guang Sun. Perturbation analysis of the matrix equation $X = Q + A^H(\widehat{X} - C)^{-1}A$. *Linear Algebra Appl.*, 372:33–51, 2003.

[18] Ji-guang Sun. Backward perturbation analysis of the periodic discrete-time algebraic Riccati equation. *SIAM J. Anal. Appl.*, 26:1–19, 2004.

[19] Ji-guang Sun. Structured backward error for the linear system $A^T A x = b$. *Journal of Natural Sciences of Heilonggjiang University*, 21(4), 2004.

[20] Ji-guang Sun. On the sensitivity of the oblique projection. Report UMINF-05.03, ISSN-0348-0542, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, 2005.

[21] Ji-guang Sun. On the sensitivity of the spectral projection. *Linear Algebra Appl.*, 395:83–94, 2005.

[22] Ji-guang Sun. Perturbation Bounds for Subspaces Associated with Periodic Eigenproblems. *Taiwanese Journal of Mathematics*, 9(1):17–38, 2005.

Algorithms and High Performance Library Software for CACSD

[1] B. Adlerborn, B. Kågström, and D. Kressner. Parallel Variants of the Multishift QZ Algorithm with Advanced Deflation Techniques . In B. Kågström et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2006*, Lecture Notes in Computer Science, LNCS 4699, pages 117–126. Springer, 2007.

[2] P. Andersson, R. Granat, and B. Kågström. Parallel Algorithms for Triangular Periodic Sylvester-type Matrix Equations. In E. Luque, T. Margalef, and D. Benítez, editors, *Euro-Par 2008 Parallel Processing – 14th International Euro-Par Conference*, volume LNCS 5168 of *Lecture Notes in Computer Science*, pages 780–789. Springer-Verlag, 2008.

[3] E. Elmroth, F. Gustavson, I. Jonsson, and B. Kågström. Recursive Blocked Algorithms and Hybrid Data Structures for Dense Matrix Library Software. *SIAM Review*, 46(1):3–45, 2004.

[4] R. Granat, I. Jonsson, and B. Kågström. Combining Explicit and Recursive Blocking for Solving Triangular Sylvester-Type Matrix Equations in Distrubuted Memory Platforms. In M. Danelutto, D. Laforenza, and M. Vanneschi, editors, *Euro-Par 2004*, volume 3149, pages 742–750. Lecture Notes in Computer Science, Springer, 2004.

[5] R. Granat, I. Jonsson, and B. Kågström. RECSY and SCASY Library Software: Recursive Blocked and Parallel Algorithms for Sylvester-Type Matrix Equations with Some Applications. In R. Ciegis et al., editor, *Parallel Scientific Computing–Advances and Applications*, volume 27, pages 3–24. Springer Optimization and Its Applications, 2009.

[6] R. Granat, I. Jonsson, and B. Kågström. Recursive Blocked Algorithms for Solving Periodic Triangular Sylvester-Type Matrix Equations. In B. Kågström et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2006*, Lecture Notes in Computer Science, LNCS 4699, pages 531–539. Springer, 2007.

[7] R. Granat and B. Kågström. Evaluating Parallel Algorithms for Solving Sylvester-Type Matrix Equations: Direct Transformation-Based versus Iterative Matrix-Sign-Function-Based Methods. In J. Dongarra et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2004*, Lecture Notes in Computer Science, LNCS 3732, pages 719–729. Springer, 2006.

[8] R. Granat and B. Kågström. Algorithm XXX: The SCASY software library – parallel solvers for Sylvester-type matrix equations with applications in condition estimation, Part II. *ACM Trans. Math. Software* (accepted), February 2010.

[9] R. Granat and B. Kågström. Parallel solvers for Sylvester-type matrix equations with applications in condition estimation, Part I: Theory and algorithms. February 2010. *ACM Trans. Math. Software* (accepted).

[10] R. Granat, B. Kågström, and D. Kressner. MATLAB Tools for Solving Periodic Eigenvalue Problems. In *Proc. 3rd IFAC Workshop PSYCO'07*, 2007.

[11] R. Granat, B. Kågström, and D. Kressner. A parallel Schur method for solving continuous-time algebraic Riccati equations. In *Proc. 2008 IEEE Conference on Computer Aided Control Systems Design (CACSD)*, 2008.

[12] R. Granat, B. Kågström, and D. Kressner. A Novel Parallel QR Algorithm for Hybrid Distributed Memory HPC Systems. *SIAM J. Scientific Computing* (submitted), 2009. (Also as Lapack Working Note LAWN 216).

[13] R. Granat, B. Kågström, and D. Kressner. Parallel Eigenvalue Reordering in Real Schur Forms. *Concurrency and Computation: Practice and Experience*, 21(9):1225–1250, September, 2007 (Also as Report UMINF-07.20 and LAPACK Working Note 192).

[14] R. Granat, B. Kågström, and P. Poromaa. Parallel ScaLAPACK-style Algorithms for Solving Continuous-Time Sylvester Equations. In H. et al Kosch, editor, *Euro-Par 2003 Parallel Processing*, volume 2790, pages 800–809. Lecture Notes in Computer Science, Springer, 2003.

[15] R. Granat and B. Kågström. Parallel Algorithms and Condition Estimators for Standard and Generalized Triangular Sylvester-Type Matrix Equations. In B. Kågström et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2006*, Lecture Notes in Computer Science, LNCS 4699, pages 127–136. Springer, 2007.

[16] Robert Granat. Algorithms and Library Software for Periodic and Parallel Eigenvalue Reordering and Sylvester-Type Matrix Equations with Condition Estimations. *PhD Thesis* UMINF-07.21, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, November, 2007.

[17] F. Gustavson, L. Karlsson, and B. Kågström. Distributed SBP Cholesky factorization algorithms with near-optimal scheduling. *ACM Trans. on Math. Software*, 36(2):11:1–11:25, March 2009. (Also published as Report UMINF 07.19 and IBM Research Report RC24342).

[18] F. Gustavson, L. Karlsson, and B. Kågström. Parallel and cache-efficient in-place matrix storage format conversion. *ACM Trans. on Math. Software* (submitted), February 2010. (Also published as Report UMINF 10.05).

[19] F. Gustavson, L. Karlsson, and B. Kågström. Three Algorithms for Cholesky Factorization on Distributed Memory Using Packed Storage. In B. Kågström et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2006*, Lecture Notes in Computer Science, LNCS 4699, pages 550–559. Springer, 2007.

[20] I. Jonsson and B. Kågström. Recursive blocked algorithms for solving triangular systems. Part I. One-sided and coupled Sylvester-type matrix equations. *ACM Trans. Math. Software*, 28(4):392–415, 2002.

[21] I. Jonsson and B. Kågström. Recursive blocked algorithms for solving triangular systems. Part II. Two-sided and generalized Sylvester and Lyapunov matrix equations. *ACM Trans. Math. Software*, 28(4):416–435, 2002.

[22] I. Jonsson and B. Kågström. RECSY - A High Performance Library for Solving Sylvester-Type Matrix Equations. In Kosch H. et al, editor, *Euro-Par 2003 Parallel Processing*, volume 2790 of *Lecture Notes in Computer Science*, pages 810–819. Springer-Verlag, 2003.

[23] Isak Jonsson. Recursive Blocked Algorithms, Data Structures, and High-Performance Software for Solving Linear Systems and Matrix Equations. *PhD Thesis* UMINF-03.17, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, December, 2003.

[24] B. Kågström. Management of Deep Memory Hierarchies—Recursive Blocked Algorithms and Hybrid Data Structures for Dense Matrix Computations. In J. Dongarra et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2004*, Lecture Notes in Computer Science, LNCS 3732, pages 21–32. Springer, 2006.

[25] B. Kågström and D. Kressner. Multishift Variants of the QZ Algorithm with Aggressive Early Deflation. *SIAM J. Matrix Anal. Appl.*, 29(1):199–227, 2006.

[26] B. Kågström, D. Kressner, E. Quintana-Orti, and G. Quintana-Orti. Blocked Algorithms for the Reduction to Hessenberg-Triangular Form Revisited. *BIT Numerical Mathematics*, 48(1):563–584, 2008.

[27] L. Karlsson and B. Kågström. A Framework for Dynamic Node Scheduling of Two-Sided Blocked Matrix Computations. In *State of the Art in Scientific and Parallel Computing, PARA 2008, Lecture Notes in Computer Science* (to appear). Springer, 2009.

[28] Lars Karlsson. *Blocked and Scalable Matrix Computations — Packed Cholesky, In-Place Transposition, and Two-Sided Transformations.* Ph. Licentiate Thesis, Dept. of Computing Science, Umeå University, Sweden, 2009. Report UMINF 09.11, ISBN 978–91–7264–788–6.

[29] Lars Karlsson. Blocked in-place transposition with application to storage format conversion. Technical Report UMINF 09.01, Dept. of Computing Science, Umeå University, Sweden, 2009.

[30] D. Kressner. Block algorithms for reordering standard and generalized Schur forms. *ACM Trans. Math. Software*, 32(4):521–532, 2006.

[31] D. Kressner. Block variants of Hammarling's method for solving Lyapunov equations. *ACM Trans. Math. Software*, 34(1):1–15, 2008.

[32] C. Lacoursière. A parallel block iterative method for interactive contacting rigid multibody simulations on multicore PCs. In *PARA'06*, pages 956–965, 2006.

[33] RECSY - High Performance library for Sylvester-type matrix equations. See `http://www8.cs.umu.se/research/parallel/recsy`.

[34] SCASY - ScaLAPACK-style solvers for Sylvester-type matrix equations. See `http://www8.cs.umu.se/research/parallel/scasy`.

Web and Grid Computing Environments

[1] E. Elmroth and R. Skelander. Semi-automatic generation of grid computing interfaces for numerical software libraries. In J. Dongarra et.al., editor, *PARA'04 State-of-the-Art in Scientific Computing Conference Proceedings*, volume LNCS 3732 of *Lecture Notes in Computer Science*, pages 404–412, 2006.

[2] P. Johansson and D. Kressner. Semi-automatic generation of web-based computing environments for software libraries. In *Computation Science – ICCS 2002*, number LNCS 2329 in Lecture Notes in Computer Science, pages 827–880. Springer, 2002.

[3] Pedher Johansson. Software Tools for Matrix Canonical Computations and Web-Based Software Library Environments. *PhD Thesis* UMINF-06.30, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, November, 2006.

[4] J. Tångrot, L. Wang, B. Kågström, and U. Sauer. Design, Construction and Use of the FISH Server. In B. Kågström et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2006*, Lecture Notes in Computer Science, LNCS 4699, pages 647–657. Springer, 2007.