

E-LETTER of the Numerics in Control Network NICONET
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1 Welcome to the NICONET E-letter number 13!

This E-letter is sent out quarterly and informs you about the newest updates. Also, new NICONET reports and important NICONET activities are announced in this E-letter.

The next issue of this E-letter is planned for January 31, 2002. Please send contributions before January 20. In particular, we encourage contributors to provide information on the use of the SLICOT library (performance, improvements, new suggestions). Officially, the EC funded thematic

network NICONET terminates at the end of this year 2001 but we asked for a prolongation of the network for 6 months and hope that the Ec will approve it very soon. However, even without EC funding, NICONET will continue maintenance of the SLICOT software.

Sabine Van Huffel
Chairperson of WGS and Coordinator of NICONET.

2 New additions to SLICOT since July 2001

Communicated by Vasile Sima:

The latest changes in the library contents or routine updates - till the next SLICOT Release - are announced in the file Release.Notes, located in directory /pub/WGS/SLICOT/ on the WGS ftp site. Previous updates are described, in reverse chronological order, in the file Release.History, located in the same directory.

SLICOT routines can be downloaded from the WGS ftp site:

<ftp://wgs.esat.kuleuven.ac.be/>

(directory pub/WGS/SLICOT/ and its subdirectories) in compressed (gzipped) tar files. On line .html documentation files are also provided there. The library and its documentation are also accessible from the WGS homepage at the World Wide Web URL:

<http://www.win.tue.nl/niconet/>

after linking from there to the SLICOT web page and clicking on the FTP site link in the freeware SLICOT section.

The latest partial SLICOT Library update took place on October 3, 2001. The changes and additions described below were not yet performed in the compressed library files (slicot.tar.gz and slicotPC.zip), but they are included in the files update.tar.gz (for Unix platforms) and update.zip (for Windows platforms). These files are located in the directory pub/WGS/SLICOT/ of the SLICOT ftp site.

Known bugs have been removed. This involved few changes in the routines AB09IY, IB01BD, IB01PD, IB01PX, IB01PY, SB16AD, and SB16BD, in the example program TAB09ID, and in the m-files or mexfiles slinorm, aresol, aresolc, findBD, and find_models (from ident_demo.zip). The documentation files for AB09ID, AB09IX, SB16AD, and SB16CD have also been updated. Details are given in the file Release.Notes.

A new routine, SB10ZD, and the associated example program and mexfile (dlsdz) have been added. This routine computes the matrices of a positive feedback controller in the Discrete-Time Loop Shaping Design Procedure. A useful Matlab file, Contents.m, has been written, which lists the SLICOT m-files and mexfiles and their function.

A new file, plicmr.tar.gz, has been added to the SLICOT root directory. It contains 3 model reduction routines, 7 associated routines (solvers for coupled stable Lyapunov/Stein equations, stable Sylvester equations, etc.), and 12 lower-level routines, all for parallel computers. Specifically, the following functionality is covered:

- Balance and Truncate method.

- Singular Perturbation Approximation method.
- Hankel Norm Approximation method.
- coupled Lyapunov equations solver for the Cholesky factors (based on the Newton iteration for the matrix sign function).
- coupled Stein equations solver for the Cholesky factors (based on the Smith iteration).
- stable Sylvester equation solver (based on the Newton iteration for the matrix sign function).
- SVD of a matrix product.
- matrix sign function using classical Newton iteration.
- rank of upper triangular matrices.

Details are given in the incorporated .html documentation, accessible from the file index.html, included in the archive.

 3 New NICONET Reports since July 2001

Communicated by Sabine Van Huffel:

The following NICONET reports can be downloaded as compressed postscript files from the World Wide Web URL:

<http://www.win.tue.nl/niconet> and choose: reports

or from the WGS ftp site:

<ftp://wgs.esat.kuleuven.ac.be> (directory pub/WGS/REPORTS/)

FILE NAME: SLWN2001-4.ps.Z

REPORT NUMBER: 2001-4

FORMAT: Compressed postscript.

AUTHORS: Isak Jonsson and Bo Kagstrom

TITLE: Recursive Blocked Algorithms for Solving Triangular Matrix Equations---Part I: One-Sided and Coupled Sylvester-Type Equations

ABSTRACT: Triangular matrix equations appear naturally in estimating the condition numbers of matrix equations and different eigenspace computations, including block-diagonalization of matrices and matrix pairs and computation of functions of matrices. To solve a triangular matrix equation is also a major step in the classical Bartels-Stewart method. We present recursive blocked algorithms for solving one-sided triangular matrix equations, including the continuous-time Sylvester and Lyapunov equations, and a generalized coupled Sylvester equation. The main parts of the computations are performed as level 3 general matrix multiply and add (GEMM) operations.

Recursion leads to an automatic variable blocking that has the potential of matching the memory hierarchies of today's HPC systems. Different implementation issues are discussed, including when to end the recursion, the design of optimized superscalar kernels for solving leaf-node triangular matrix equations efficiently, and how parallelism is utilized in our implementations. Uniprocessor and SMP parallel performance results of our recursive blocked algorithms and corresponding routines in the state-of-the-art libraries LAPACK and SLICOT are presented. The performance improvements of our recursive algorithms are remarkable, including 10-folded speedups

compared to standard algorithms.

STATUS: available since April 2001 and revised in August 2001

FILE NAME: SLWN2001-5.ps.Z

REPORT NUMBER: 2001-5

FORMAT: Compressed postscript.

AUTHORS: Isak Jonsson and Bo Kagstrom

TITLE: Recursive Blocked Algorithms for Solving Triangular
Matrix Equations---Part II: Two-sided and Generalized
Sylvester and Lyapunov Equations

ABSTRACT: We continue our study on high-performance algorithms for solving triangular matrix equations. They appear naturally in different condition estimation problems for matrix equations and various eigenspace computations, and as reduced systems in standard algorithms. Building on our successful recursive approach applied to one-sided matrix equations (Part I), we now present recursive blocked algorithms for two-sided matrix equations, which include matrix product terms such as AXB^T . Examples are the discrete-time standard and generalized Sylvester and Lyapunov equations. The means for high-performance are the recursive variable blocking, which has the potential of matching the memory hierarchies of today's high-performance computing systems, and level 3 computations which mainly are performed as GEMM operations. Different implementation issues are discussed, focusing on similarities and differences between one-sided and two-sided matrix equations. We present uniprocessor and SMP parallel performance results of recursive blocked algorithms and routines in the state-of-the-art SLICOT library. The performance improvements of our recursive algorithms are remarkable, including 10-folded speedups or more, compared to standard algorithms.

STATUS: available since September 2001

FILE NAME: SLWN2001-6.ps.Z

REPORT NUMBER: 2001-6

FORMAT: Compressed postscript.

AUTHORS: Chris Denruyter

TITLE: Solving Sylvester equations for Model Reduction:
Slicot vs. Matlab

ABSTRACT: In this report, we compare two Sylvester equation solvers: the Matlab function `lyap` and the Slicot function `slylv`. An algorithm designed for model reduction and based on the resolution of a Sylvester equation is presented. In this context, timing results show the superiority of the Slicot based `m.file slylv`.

STATUS: available since October 2001

4 NICONET events

Communicated by Peter Benner:

The workshop and training course

ADVANCED COMPUTATIONAL TOOLS FOR COMPUTER-AIDED CONTROL SYSTEMS DESIGN

took place on September 27-29, 2001, at University of Bremen, Germany

This workshop and training course was intended as a tutorial on the use

of the freeware Subroutine Library in Systems and Control Theory (SLICOT) for solving practical control engineering problems within computer-aided control systems design (CACSD) environments. The exercises solved by the participants during the hands-on training sessions demonstrated that SLICOT-based software usually has improved reliability and efficiency as well as extended functionality compared to the computational methods implemented in other CACSD software packages.

The workshop was organized by Angelika Bunse-Gerstner and Peter Benner from the Zentrum für Technomathematik/AG Numerik of the University of Bremen, Germany, in cooperation with the Numerics in Control Network (NICONET) funded by the European Community BRITE-EURAM III Thematic Networks Programme.

The workshop was attended by 39 participants from Belgium, Bulgaria, France, Germany, Great Britain, The Netherlands, Romania, Spain, Sweden, and Switzerland. The workshop provided a stimulating atmosphere for discussions on how to use SLICOT-based software in industrial applications. Some posters during the poster session on Thursday, September 27, showed the performance of the SLICOT software for use in Matlab and Scilab applied to real-world problems.

Major topics of the course were

- * basic control software
- * system identification
- * model reduction
- * robust control design using H-infinity techniques

The program of the workshop was as follows:

Thursday, September 27, 2001

09.00 - 09.15 Welcome addresses (Sabine Van Huffel, Angelika Bunse-Gerstner)
09.15 - 09.45 Introduction to NICONET and SLICOT (Sabine Van Huffel)
09.45 - 10.30 The backbone of reliable numerical software: BLAS and LAPACK (Sven Hammarling)
10.30 - 11.00 Coffee break
11.00 - 12.00 The Matlab Control Toolbox (Helmuth Stahl)
12.00 - 13.30 Lunch
13.30 - 14.15 Basic control software (Paul Van Dooren, Peter Benner)
15.00 - 16.00 Coffee & Posters
16.00 - 19.00 Training Part I (Vasile Sima)

Friday, September 28, 2001

09.00 - 10.30 System identification with SLICOT (Vincent Verdult)
10.30 - 11.00 Coffee break
11.00 - 12.30 SLICOT model reduction tools (Andras Varga)
12.30 - 14.00 Lunch
14.00 - 15.00 Applications of SLICOT in industry (Joris de Cuyper)
15.00 - 15.30 Coffee break
15.30 - 18.30 Training II (Vasile Sima)
19:30 - 23:00 Banquet

Saturday, September 29, 2001

09.00 - 10.30 Robust control design using SLICOT (Petko Petkov, Da-Wei Gu)
10.30 - 11.00 Coffee break
11.00 - 13.00 Training III (Vasile Sima)

13.00 - 14.00 Lunch

During the poster session participants presented their own projects and discussed current problems or open questions. The following posters were presented:

Peter Benner, Enrique Quintana-Ortí, Gregorio Quintana-Ortí:
Model reduction of large-scale dense systems

Younès Chahlaoui, Antoine Vandendorpe, Paul Van Dooren:
Model reduction of large-scale dynamical systems via Multipoint Padé

Francois Delebecque, Serge Steer:
Scilab-SLICOT

Erik Elmroth, Pedher Johansson, Bo Kågström, Daniel Kressner, Volker Mehrmann:
SLICOT Web Computing

Heike Faßbender, Peter Benner:
SLICOT drives tractors!

Sven Hammarling:
LAPACK and ScaLAPACK: The underlying linear algebra for SLICOT

Inès Ferrer-Mallorquí
Interval-based tools for robust control

Ivan Markovsky, Sabine Van Huffel:
Element-Wise Weighted Total Least Squares

Ivan Markovsky, Sabine Van Huffel, Bart De Moor:
Multi-Model System Parameter Estimation

Horst Schulte:
Motion control for servo-pneumatic actuators using Takagi-Sugeno fuzzy models

Diana Maria Sima, Vasile Sima, Sabine Van Huffel:
Recent Developments in SLICOT Library for System Identification

Besides the scientific program, the conference dinner at the "Meierei" certainly was one of the highlights of the workshop. Photos of this event and other workshop snapshots can be viewed at and downloaded from

<http://www.math.uni-bremen.de/zetem/workshops/cacsd/Photos/photos.html>

5 (Forthcoming) Meetings and symposia attended by NICONET partners

Communicated by Vasile Sima and Sabine Van Huffel:

Conferences related to the NICONET areas of interest, where NICONET partners presented NICONET/SLICOT-related talks and papers, and/or disseminate information and promote SLICOT, are the following:

CG50-GG70 meeting, a conference commemorating 50 years of conjugate gradients and celebrating Gene Golub's 70th birthday, ETH Zurich, February 18-20, 2001.

GAMM Annual meeting, Augsburg, Germany, March 25-28, 2002.

IFAC symposium on parameter estimation, Barcelona, Spain, March 2002.

Householder symposium, 16-21 June 2001, Scotland.

MTNS, 'Mathematical Theory of networks and Systems' meeting 2002,
University of Notre Dame, South Bend, Indiana, USA, August 12-16, 2002,
see <http://www.nd.edu/~mtns/>

END OF THE NICONET E-LETTER
