
E-LETTER of the Numerics in Control Network NICONET
Issue no. 14, February 4, 2002

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1 Welcome to the NICONET E-letter number 14!

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. First of all, as mentioned in our previous E-letter, our new EC proposal we submitted in the Growth programme (accompanying measures) in March 2001 hasn’t been approved. We have to wait now for new calls in the 6th framework before we can resubmit our proposal. In the mean time we asked the EC to extend our present thematic network project NICONET with 6 months until July 1, 2002, and this extension has been approved. Since September 2001 our international society, also called NICONET, is operational. Any funding received through this society is used for the further development of the SLICOT library and will be needed in periods where no EC funding is available. Simultaneously, this society promotes and supervises the dissemination of the SLICOT software.

The next issue of this E-letter is planned for April 2001. Please send contributions before March 30. In particular, we encourage

contributors to provide information on the use of the SLICOT
library (performance, improvements, new suggestions).

Sabine Van Huffel
Chairperson of WGS and Coordinator of NICONET.

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2 New issue of the NICONET Newsletter available

Communicated by Sabine Van Huffel:

The 8-th issue of our NICONET Newsletter is now available and can
be downloaded as compressed postscript file from the World Wide
Web URL:

http://www.win.tue.nl/niconet/   and choose: Newsletters

or from the WGS ftp site:

ftp://wgs.esat.kuleuven.ac.be (directory pub/WGS/NEWSLETTER/)
(filename: issue-1-02.ps.Z)

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3 New additions to SLICOT since October 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 major SLICOT Library update took place on October 3, 2001.
Few changes have been made in the routines AB09IY, IB01BD, IB01PD,
IB01PX, IB01PY, SB16AD, and SB16BD, for removing some bugs.
Also, five m/mexfiles (slinorm.m, aresol.f, aresolc.f, findBD.f, and
find_models.m) have been updated. Details are given in the file
Release.Notes.

A new routine, and associated mexfile and example program, have been
added to compute the matrices of a positive feedback controller in the
Discrete-Time Loop Shaping Design Procedure.

In addition, the file plicmr.tar.gz has been put 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.
Details are given in the incorporated .html documentation, accessible from the file index.html, included in the archive.

Over 20 new user-callable and computational routines for basic control problems, and identification of Wiener systems, have been implemented and will be posted soon on the SLICOT ftp site. They include Identification Routines, Mathematical Routines, and Transformation Routines, performing the following main computational tasks:

- compute a set of parameters for approximating a Wiener system in a least-squares sense, using a neural network approach and a Levenberg-Marquardt algorithm.
- solve a system of linear equations A*x = b, with A symmetric, positive definite, or, in the implicit form, f(A, x) = b, where y = f(A, x) is a symmetric positive definite linear mapping from x to y, using the conjugate gradient algorithm without preconditioning.
- solve a set of systems of linear equations, A^T*A*X = B, or, in the implicit form, f(A)*X = B, with A^T*A or f(A) positive definite, using symmetric Gaussian elimination.
- solve a system of linear equations A*x = b, D*x = 0, in the least squares sense, with D a diagonal matrix, given a QR factorization with column pivoting of A.
- find the parameters theta for a function F(x, theta) that give the best approximation for y = F(x, theta) in a least-squares sense using a Levenberg-Marquardt algorithm based on conjugate gradients for solving linear systems.
- find the parameters theta for a function F(x, theta) that give the best approximation for y = F(x, theta) in a least-squares sense using a Levenberg-Marquardt algorithm based on QR factorization with column pivoting.
- compute the QR factorization with column pivoting of an m x n matrix J (m >= n), that is, J*P = Q*R, where Q is a matrix with orthogonal columns, P a permutation matrix, and R an upper trapezoidal matrix with diagonal elements of nonincreasing magnitude, and apply the transformation Q^T on the error vector e; the 1-norm of the scaled gradient is also returned.
- find a value for the parameter lambda such that if x solves the system A*x = b, sqrt(lambda)*D*x = 0, in the least squares sense, where A is an m x n matrix, D is an n x n nonsingular diagonal matrix, and b is an m-vector, and if delta is a positive number, then either lambda = 0 and (|| D*x ||_2 - delta) <= 0.1*delta, or lambda > 0 and | || D*x ||_2 - delta | <= 0.1*delta. It is assumed that a QR factorization with column pivoting of A is available.
- compute the output of a Wiener system.
- compute the output of a set of neural networks.
- compute the Jacobian of a Wiener system.
- find a value for the parameter lambda such that if x solves the system J*x = b, sqrt(lambda)*D*x = 0, in the least squares sense, where J is an m x n matrix, D is an n x n nonsingular diagonal matrix, and b is an m-vector, and if delta is a positive number, then either lambda = 0 and (|| D*x ||_2 - delta) <= 0.1*delta, or lambda > 0 and | || D*x ||_2 - delta | <= 0.1*delta. It is assumed that a QR factorization with block column pivoting of J is available, that is, J*P = Q*R, where P is a permutation matrix, Q has orthogonal columns, and R is an upper triangular matrix with diagonal elements of nonincreasing magnitude for each block.
- solve a system of linear equations J*x = b, D*x = 0, in the least squares sense, with D a diagonal matrix, given a QR factorization with block column pivoting of J.
- solve one of the systems of linear equations R*x = b, or R^T*x = b, in the least squares sense, where R is an n x n block upper triangular matrix, with the structure

```
          R_1   0   ...   0   L_1
           0   R_2  ...   0   L_2
           :    :    :    :    :
           0    0   ...  R_l  L_l
           0    0   ...   0  R_l+1
```

  with the upper triangular submatrices R_k, k = 1 : l+1, square, and
  the first l of the same order. The diagonal elements of each block R_k
  have nonincreasing magnitude. The matrix R is stored in a compressed form.
- compute the QR factorization with block column pivoting of an
  m x n matrix J (m >= n), that is, J*P = Q*R, where Q is a matrix with
  orthogonal columns, P a permutation matrix, and R an upper trapezoidal
  matrix with diagonal elements of nonincreasing magnitude for each block,
  and apply the transformation Q^T on the error vector e;
  the 1-norm of the scaled gradient is also returned.
- compute the matrix J^T*J + c*I, for the Jacobian J given in a
  compressed form.
- compute the matrix J^T*J + c*I, for the Jacobian J fully given, for
  one output variable.
- compute the matrix-vector product x <- (J^T*J + c*I)*x, where J is
  given in a compressed form.
- compute x <- (A^T*A + c*I)*x, where A is an m x n real matrix, and
  c is a scalar.
- compute the Jacobian of the error function for a neural network
  (for one output variable).
- convert the linear discrete-time system given as (A, B, C, D),
  with initial state x_0, into the output normal form, with
  parameter vector theta. The matrix A is assumed to be stable.
  The matrices A, B, C, D and the vector x_0 are transformed, so
  that on exit they correspond to the system defined by theta.
- convert the linear discrete-time system given as its output
  normal form, with parameter vector theta, into the state-space
  representation (A, B, C, D), with the initial state x_0.
- compute the output sequence of a linear time-invariant open-loop
  system given by its discrete-time state-space model (A,B,C,D), where
  A is an n x n general matrix (the input and output trajectories are
  stored differently from SLICOT Library routine TF01MD).

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4. SLICOT developments

Communicated by Sabine Van Huffel:

New SLICOT toolboxes for controller reduction, model reduction of
high order systems, and robust control are made available on the
website now. Toolboxes for nonlinear subspace identification and
nonlinear systems will be available in March 2002.

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5 New NICONET Reports since October 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 slsylv. 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 slsylv.

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STATUS:         available since October 2001

FILE NAME:      SLWN2001-7.ps.Z
REPORT NUMBER:  2001-7
FORMAT:         Compressed postscript.
AUTHORS:        P.Hr. Petkov, D.W. Gu and MM. Konstantinov
TITLE:          Robust control of a disk drive servo system
ABSTRACT:       In this expository paper we show the application of some of
                the SLICOT routines in the robust control analysis and
                design of a disk drive servo system. An uncertainty model of
                the system plant is first derived which contains eleven
                uncertain parameters including four resonance frequencies,
                four damping coefficients and three rigid body model
                parameters. Three controllers for the uncertain system are
                designed using, respectively, the techniques of H_inf mixed
                sensitivity design, H_inf loop shaping design procedure
               (LSDP) and mu-synthesis method. With these controllers the
                closed-loop system achieves robust stability and in the
                cases of H_inf and mu-controllers the closed loop system
                practically achieves robust performance. A detailed
                comparison of the frequency domain and time domain
                characteristics of the closed-loop system with the three
                controllers is conducted.
                Further, model reduction routines have been applied to find
                a reasonably low order controller based on the mu-synthesis
                design. This reduced order controller maintains the robust
                stability and robust performance of the closed-loop system.
                Simulations of the nonlinear sampled-data servo system with
                the low order controller have been included as well, which
                confirms the practical applicability of the controller
obtained.
STATUS:         available since December 2001

FILE NAME:      SLWN2002-1.ps.Z
REPORT NUMBER:  2002-1
FORMAT:         Compressed postscript.
AUTHORS:        Peter Benner, Enrique S. Quintana-Orti, Gregorio Quintana-
Orti,
                Rafael Mayo
TITLE:          Enhanced Services for Remote Model Reduction of
                Large-Scale Dense Linear Systems
ABSTRACT:       This paper describes enhanced services for remote model
                reduction of large-scale, dense linear time-invariant
                systems. Specifically, we describe a mail service and
                a web service for model reduction on a cluster of Intel
                Pentium-II architectures using absolute and relative
                error methods. Experimental results show the appeal and
                accessibility provided by these services.
STATUS:         available since January 2002
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6 NICONET events

The NICONET project has been extended with 6 months. An extra
meeting of all partners is planned in Oxford on April 8, 2002.

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7 (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 or will present 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, 2002.

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

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

15th Householder symposium on Numerical Linear Algebra, Peebles Hotel Hydro, Scotland, June 17-21, 2002.

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/

Joint ‘‘IEEE Conference on Control Applications’’ and ‘‘IEEE Conference on Computer Aided Control Systems Design’’, September 17-20, 2002, Scottish Exhibition & Conference Centre, Glasgow, Scotland.

END OF THE NICONET E-LETTER
