

E-LETTER of the Numerics in Control Network NICONET
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http://www.win.tue.nl/wgs/E-letter.html

or from the WGS ftp site:

ftp://wgs.esat.kuleuven.ac.be (directory pub/WGS/E-LETTER/)

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1 Welcome to the NICONET E-letter number 2!

As announced in our first issue, this E-letter informs you about the newest updates of the SLICOT library, the main product of NICONET, and its performance. Also, new NICONET reports and newsletters, as well as our NICONET workshops, are announced in this E-letter.

The importance of numerics in control software for industry was also the topic of our first NICONET workshop held in Valencia on December 4, 1998. Section 6 describes the highlights of this one-day workshop. Our next workshop will be held in France in December 1999 (see Section 7).

The next issue of this E-letter is planned for April 1999. Please send contributions before April 15. 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 second 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/wgs/Newslet.html

or from the WGS ftp site:

  ftp://wgs.esat.kuleuven.ac.be (directory pub/WGS/NEWSLETTER/)
                                (filename: issue-1-99.ps.Z)

Contents:

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3 New additions to SLICOT since October 1998

Communicated by Vasile Sima:

The latest SLICOT Library update took place in December 1998. Several new user-callable routines for basic control problems have been made available on the ftp site. They include Analysis Routines and Synthesis Routines, performing the following tasks:

- model reduction for unstable systems using the optimal Hankel-norm approximation method in conjunction with square-root balancing for the alpha-stable part of the system;
- model reduction for unstable systems using either the square-root or the balancing-free square-root Balance & Truncate (B & T) method in conjunction with left/right stable coprime factorization techniques;
- model reduction for unstable systems using either the square-root or the balancing-free square-root Singular Perturbation Approximation (SPA) model reduction method in conjunction with stable left/right coprime factorization techniques;
- compute the Hankel-norm of the alpha-stable projection of a transfer-function matrix for a state-space system;
- compute the H2 or L2 norm of the transfer-function matrix of a system without poles on the imaginary axis, for a continuous-time system, or on the unit circle, for a discrete-time system; if the H2-norm is computed, the system must be stable;
- apply a specified symplectic scaling to a Hamiltonian matrix;
- transform a Hamiltonian matrix to square-reduced form by a symplectic orthogonal similarity transformation;
- compute the eigenvalues of a Hamiltonian matrix in square-reduced form;

- compute the state-space representations of the factors of a left
  coprime factorization with prescribed stability degree;
- compute the state-space representations of the factors of a right
  coprime factorization with prescribed stability degree;
- compute the state-space representations of the factors of a left
  coprime factorization with co-inner denominator of a transfer-function
  matrix;
- compute the state-space representations of the factors of a right
  coprime factorization with inner denominator of a transfer-function
  matrix;
- compute the state-space representation of the transfer-function
  corresponding to a left coprime factorization;
- compute the state-space representation of the transfer-function
  corresponding to a right coprime factorization;
- solve for X either the generalized continuous-time Lyapunov equation

  op(A)'*X*op(E) + op(E)'*X*op(A) = sigma*Y,

  or the generalized discrete-time Lyapunov equation

  op(A)'*X*op(A) - op(E)'*X*op(E) = sigma*Y,

  where op(M) is either M or M' (M transpose), A and E are square
  matrices, the right hand side Y is symmetric, and sigma is a scale
  factor set to avoid overflow in X.
- solve for X = op(U)'*op(U) either the generalized c-stable
  continuous-time Lyapunov equation

  op(A)'*X*op(E) + op(E)'*X*op(A) = - sigma**2*op(B)'*op(B),

  or the generalized d-stable discrete-time Lyapunov equation

  op(A)'*X*op(A) - op(E)'*X*op(E) = - sigma**2*op(B)'*op(B),

  where A and E are square matrices, B is a rectangular matrix,
  U is an upper triangular matrix with non-negative entries on its
  main diagonal, and sigma is a scale factor set to avoid overflow
  in U.

In addition, the previously existing model reduction routines have been improved. The workspace needed has been reduced, and several bugs have been fixed. 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, mentioned below. 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/wgs/

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

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4 New NICONET Reports since October 1998

Contributed 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/wgs/reports.html

or from the WGS ftp site:

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

FILE NAME: SLWN1998-6.ps.Z
REPORT NUMBER: 1998-6
FORMAT: Compressed postscript.
AUTHORS: W. Favoreel, V. Sima, S. Van Huffel, M. Verhaegen, B. De Moor
TITLE: Subspace model identification of linear systems in SLICOT
ABSTRACT: This paper compares 3 commonly used subspace identification algorithms N4SID, MOESP and CVA, using their Matlab implementation, in terms of prediction accuracy, simulation accuracy and computational efficiency. The comparison is made on the basis of 15 publicly available practical datasets to which the codes are applied.
STATUS: available since October 1998

FILE NAME: SLWN1998-9.ps.Z
REPORT NUMBER: 1998-9
FORMAT: Compressed postscript.
AUTHORS: Daniel Kressner, Volker Mehrmann and Thilo Penzl
TITLE: CTDSX - a Collection of benchmark examples for state-space realizations of continuous-time dynamical systems
ABSTRACT: This paper describes a benchmark collection for state-space realizations of time-invariant continuous-time dynamical systems. The collection is intended to provide a means for testing the correctness, accuracy, and speed of numerical methods for several problems arising in control theory. It has been implemented in FORTRAN and MATLAB.
STATUS: available since November 1998

FILE NAME: SLWN1998-10.ps.Z
REPORT NUMBER: 1998-10
FORMAT: Compressed postscript.
AUTHORS: Daniel Kressner, Volker Mehrmann and Thilo Penzl
TITLE: DTDSX - a Collection of benchmark examples for state-space realizations of discrete-time dynamical systems
ABSTRACT: This paper describes a benchmark collection for state-space realizations of time-invariant discrete-time dynamical systems. The collection is intended to provide a means for testing the correctness, accuracy, and speed of numerical methods for several problems arising in control theory. It has been implemented in FORTRAN and MATLAB.
STATUS: available since November 1998

FILE NAME: nic1999-1.ps.Z
REPORT NUMBER: 1999-1
FORMAT: Compressed postscript.
AUTHORS: Peter Benner, Enrique S. Quintana-Orti, Gregorio Quintana-Orti
TITLE: A portable subroutine library for solving linear control problems on distributed memory computers
ABSTRACT: This paper describes the design of a software library for solving the basic computational problems that arise in analysis and synthesis of linear control systems. The library is intended for use in high performance computing environments based on parallel distributed memory architectures. The portability of the library is ensured by using the BLACS, PBLAS, and ScaLAPACK as the basic layer of communication and computational routines. Preliminary

numerical results demonstrate the performance of the developed codes on parallel computers. The suggested library can serve as a basic layer for PSLICOT, a parallel extension of the Subroutine Library in Control Theory (SLICOT).
STATUS: available since January 1999

FILE NAME: nic1999-2.ps.Z
REPORT NUMBER: 1999-2
FORMAT: Compressed postscript.
AUTHORS: Peter Benner and Heike Fassbender
TITLE: SLICOT drives tractors!
ABSTRACT: We describe the successful application of a SLICOT subroutine in a control engineering problem. Based on GPS data it is possible to automatically steer farm vehicles along a prescribed trajectory. The bottleneck for the successful on-line implementation of a LQG regulator is the numerical solution of a discrete-time algebraic Riccati equation in real-time and at high accuracy. This is achieved employing a Fortran-77 subroutine from the Subroutine Library in Control Theory SLICOT.
STATUS: available since January 1999

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5 NICONET visits since October 1998

Ad van den Boom visited Michel Verhaegen in Delft on November 2, 1998 to discuss issues of nonlinear identification methods.

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6 Meetings and symposia attended by NICONET partners

A NICONET workshop has been organized on December 4, 1998, in Valencia and was attended by 51 people. The program, outlined below, included plenary lectures, poster presentations and two demonstrations on the use of SLICOT and some newly implemented routines.

WORKSHOP PROGRAMME

9:15 Registration
9:45 Welcome and Introduction
10:00 Plenary Session: Prof. Pedro Albertos:
Discrete Time Nonlinear Systems Models for Control
11:00 Coffee Break
11:30 Plenary Session: Prof. Ton Backx:
Numerical Problems in Industrial Control Systems
12:30 Plenary Session: Dr. Ad van den Boom / Dr. Vasile Sima:
Performance and Applicability of the SLICOT Library

13:30 Lunch

15:30 Afternoon Schedule
15:35 First Poster Session
16:30 Coffee Break
17:00 Second Poster Session
18:00 Demo Session: Dr. Vasile Sima:
Demonstration on the Use of the SLICOT Library
18:30 Demo Session: Prof. Petko Petkov / Prof. Mihail Constantinov:
Demonstration on the Codes for Hinf and H2 Design
19:00 Panel discussion: moderated by Prof. V. Hernandez and Prof. S. Van Huffel:
The Importance and Needs of Numerics in Control Software in Industry
19:30 End of the Meeting

A total of 27 posters were presented during the workshop covering different areas of control, such as model reduction, robotics, numerics, parallel computing, robust control and others, as listed below.

Parallel Solution of the Generalized Lyapunov Equation using Hammarling's Method; D. Guerrero, V. Hernandez, J. E. Roman, A. M. Vidal

Solving the Generalized Lyapunov Equation by the Bartels-Stewart Method using Parallel Standard Software Libraries; I. Blanquer, H. Claramunt, V. Hernandez, A. M. Vidal

Direct Formulae for the H-inf Sub-Optimal Central Controller; D. W. Gu, P. H. Petkov, M. M. Konstantinov

Fortran 77 Routines for H-inf and H2 Design of Linear Control Systems; P. H. Petkov, D. W. Gu, M. M. Konstantinov

Efficient and Reliable Algorithms for Control Theory Computations; V. Sima

Model Reduction of High Order Systems: Methods and Software; A. Varga

Combination of Linear Subspace Algorithms with Stabilization Diagrams to Model Multi-axial Durability Test Rigs Based on Input-Output Data Sets; J. De Cuyper, R. Fraanje, D. Coppens

Using Interval and Symbolic Computations to Deal with Uncertain Dynamic Systems; J. Vehi, I. Ferrer, J. Armengol

Detection of Periodic Orbits in Nonlinear Systems; F. Salas, T. Álamo, J. Aracil

Numerical Solvers for Discrete-Time Periodic Riccati Equations: A High Performance Computing Approach; E. Arias, V. Hernandez, R. Mayo, E. S. Quintana

A Parallel Implementation of the SLICOT Model Reduction Subroutines for Stable Systems; J. M. Alonso, F. Alvarruiz, I. Blanquer, V. Hernandez, J. E. Roman, A.M. Vidal

Distributed Memory Parallel Algorithms for Computing Integrals Involving the Matrix Exponential; E. Arias, V. Hernandez, J. J. Ibanez

Efficient Algorithms for the Regularization of Descriptor Linear Systems; V. Hernandez, E. S. Quintana-Orti, F. J. Ramirez

A Portable Library for Solving Linear Control Problems on Parallel Computers; P. Benner, I. Blanquer, A. Bunse-Gerstner, M. Castillo, J. M. Claver, H. Fassbender, V. Hernandez, R. Mayo, V. Mehrmann, E. S. Quintana-Orti, G. Quintana-Orti

FAST: Fuzzy Algorithm Stability Tool for MATLAB; F. Cuesta, F. Gordillo, J. Aracil, A. Ollero

Genetic Algorithm Approach for Nonlinear Multivariable MBPC Mobile Robot Navigation; D. R. Ramirez, D. Limon-Marruedo, J. Gomez-Ortega, E. F. Camacho

Mathematical Model for Robot Manipulators Adaptive Control; L. Penalver, J. Tornero, V. Hernandez, J. C. Fernandez

Parallel Algorithms for Adaptive Control of Robot Manipulators; J. C. Fernandez, V. Hernandez, L. Penalver, J. Tornero

Numerical Problems Related to Future Process Operations; T. C. Backx

A Parallel Implementation of the Singular Value Decomposition of the Product of Triangular Matrices; M. Mollar, V. Hernandez

A Parallel Jacobi-like Algorithm for Solving Algebraic Riccati Equations; I. Blanquer, A. Bunse-Gerstner, H. Fassbender, V. Hernandez

Computing Minimal Discrete Time-Varying Forward/Backward Periodic Realizations of Rational Matrices; E. Arias, V. D. Estruch, V. Hernandez

Comparative Study Between Three Subspace System Identification Algorithms; W. Favoreel, S. Van Huffel, B. De Moor, V. Sima, M. Verhaegen

A Comparison of Model Reduction Techniques of Large-Scale Dynamical Systems; K. Gallivan, P. Van Dooren

A Matlab Mex File Environment of SLICOT; V. Mehrmann, A. Varga, H. Xu

Benchmark Collections in SLICOT; D. Kressner, V. Mehrmann, T. Penzl

A Distributed Memory Algorithm for the Computation of Minimal Realizations of Control Linear Systems; F. Alvarruiz, V. Hernandez, P. A. Ruiz, A. M. Vidal

A booklet with the abstracts of all posters was printed and distributed to the participants. Software and printing material on SLICOT and subscription to the NICONET Newsletter was also offered to the participants.

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7 Coming NICONET events

Communicated by Vasile Sima en Sabine Van Huffel:

Our second two-days NICONET workshop will be held in the direct neighbourhood of Paris, France, on December 2-3, 1999. This workshop is open for everybody. More information follows in our next E-letter.

Forthcoming Conferences related to the NICONET areas of interest, where NICONET partners submitted or will submit proposals for NICONET/SLICOT-related talks and papers, and/or will disseminate information and promote SLICOT, are the following:

Computer-Aided Control System Design, CACSD '99, Hawaii, August 22-26, 1999.

The Fourth International Congress on Industrial and Applied Mathematics, Edinburgh, Scotland, ICIAM99, July 5-9, 1999.

European Control Conference, Karlsruhe, Germany, 31 August-3 September, 1999.

Fourteenth Householder Symposium on Numerical Linear Algebra, Chateau Whistler, Whistler B.C., Canada, June 14-18, 1999.

END OF THE NICONET E-LETTER
