12

ISSN 1373-6787

January 2004

NICONET Newsletter

Distributed by: **Working Group on Software WGS**

Contents: **Page**

Contact address of the WGS: Mrs. Ida Tassens, Secretary of WGS
Katholieke Universiteit Leuven
Dept. of Electrical Engineering (ESAT-SCD(SISTA))
Kasteelpark Arenberg 10
3001 Leuven-Heverlee, Belgium
email: ida.tassens@esat.kuleuven.ac.be
phone: + 32 16 32 17 09 and fax: + 32 16 32 19 70

1 Editorial

Welcome to the twelfth issue of the NICONET newsletter which informs you about the evolution of the SLICOT library and its integration in user-friendly environments such as `Scilab` and MATLAB, as well as about other NICONET activities related to CACSD software developments. Since July 1, 2002, our EC thematic network project came to its end. Meanwhile, the maintenance and further development of the SLICOT library was guaranteed by our international society, also called NICONET, operational since September 2001. We recently submitted a new EU coordinated action proposal, which plans a substantial extension of the SLICOT Library and the associated user-friendly software. We also announce a special issue of the IEEE Control Systems Magazine (editor Andras Varga, IEEE Fellow), containing contributions of the NICONET team members, which should appear in February 2004.

Section 2 gives more details about the newest additions to the SLICOT library, new reports and forthcoming events.

I hope you enjoy reading this newsletter.

Sabine Van Huffel
NICONET coordinator

2 NICONET information corner

This section informs the reader on how to access the SLICOT library, the main product of the NICONET project, and how to retrieve its routines and documentation. Recent updates of the library are also described. In addition, information is provided on the newest NICONET reports, available via the NICONET website or ftp site, as well as information about upcoming workshops/conferences organized by NICONET or with a strong NICONET representation.

2.1 Electronic Access to the Library

The SLICOT routines can be downloaded from the WGS ftp site, accessible via the hyperlink `SLICOT-ftp` from the NICONET homepage

```
http://www.win.tue.nl/niconet/niconet.html
```

The users are asked to accept the copyright terms and to registrate. After registration, a local Web page (which mimics the NICONET web page), is opened, and the user can browse the main contents of the ftp site and download the desired files. (At the time being, the former NICONET web pages can no longer be used for downloading the software, but only for inspecting the contents and capabilities of the SLICOT-related tools.)

The entire library is contained in the file `slicot.tar.gz` (from `SLICOT/` subdirectory of the ftp site), accessible via the hyperlink `SLICOT software` from the local NICONET Web page. The following Unix commands should be used for decompressing this file:

```
gzip -d slicot.tar
tar xvf slicot.tar
```

The created subdirectories and their contents are summarized below:

- `slicot` contains the files `libindex.html`, `make.inc`, `makefile`, and the following subdirectories:
  - `benchmark_data` contains benchmark data files for Fortran benchmark routines (`.dat`);
  - `doc` contains SLICOT documentation files for routines (`.html`);
  - `examples` contains SLICOT example programs, data, and results (`.f`, `.dat`, `.res`), and `makefile`, for compiling, linking and executing these programs;
  - `examples77` the same contents as in subdirectory `examples`, but the programs are compliant with the Fortran 77 standard (with the `MAX` and/or `MIN` intrinsic functions calls in `PARAMETER` statements removed);
  - `src` contains SLICOT source files for routines (`.f`), and `makefile`, for compiling all routines and creating an object library;
  - `SLTools` contains MATLAB `.m` files and data `.mat` files;
  - `SLmex` contains Fortran source codes for MEX-files (`.f`).

Another, similarly organized file, called `slicotPC.zip`, is accessible from the same hyperlink mentioned above, `SLICOT software`; it contains the MS-DOS version of the source codes of the SLICOT Library, and can be used on Windows 9x/2000/ME/XP or NT platforms. Included are several source makefiles.

After downloading and decompressing the appropriate SLICOT archive, the user can then browse through the documentation on his local machine, starting from the index file `libindex.html` from `slicot` subdirectory.

The ftp site also enables to download specific tools, for instance various "modules", accessible from the user-callable routines, listed in `libindex.html`. A "module" is a compressed (gzipped) tar file, which includes the following files: source code for the main routine and its example program, example data, execution results, the associated `.html` file, as well as the source code for the called SLICOT routines. Each functional "module" can be copied to the user's current directory, by clicking on an appropriate location, placed at the end of the corresponding `.html` image.

In addition, prebuilt libraries for common platforms, as well as M-files and MEX-files based on SLICOT routines, can be downloaded via the hyperlink `SLICOT software`. Moreover, related contributed Fortran routines or MATLAB functions, are also accessible from the hyperlink `additional software`.

2.2 SLICOT Library updates in the period July 2003–January 2004

There have been two major SLICOT Library updates during the period July 2003–January 2004: on September 5, 2003 and, January 3, 2004. Details are given in the files `Release.Notes` and `Release.History`, located in the subdirectory `SLICOT/`, of the SLICOT ftp site.

The *SLICOT Library update on September 5, 2003*, included changes in several routines and associated interfaces. The updated Fortran routines are: `AB05MD`, `AB05ND`, `AB05OD`, `AB05PD`, `AB05RD`, `AB05SD`, `AB13DD`, `MB05MD`, `MB05MY`, `MB05OD`, `SB01BD`, `SB01BY`, `SB08CD`, `SB08DD`, `SB08ED`, `SB08FD`, `SB10LD`, `SG03BX`, `TF01MD`, `TF01ND`, `TG01AD`, `TG01CD`, `TG01ED`, `TG01FD`, `TG01HX`, `TG01ID`, and `TG01JD` from the SLICOT Library chapters A, M, S, and T. The bugs have mainly been found and fixed while performing detailed testing using the newly developed MEX-files (see below). The updates essentially consisted in defining more restrictive conditions for performing some calculations, for instance for dealing with matrices with zero dimensions. The tests for the "Quick return" section have been modified for some of the routines listed above. Some important changes were already announced in the previous issue of the NICONET Newsletter (issue 11, July 2003), which appeared before the SLICOT Library update in September. Full details are given in the file `Release.History`.

The routine `MB03RD` has been improved, by adding two new options, which allow a "closest-neighbour" strategy (suggested by Pascal Gahinet) to be used for selecting the block to be added to the current block for block diagonalization. The previously available options use the "closest to the mean" strategy. The new strategy often performs block-diagonalization when the "old" strategy does not succeed, and/or produces better conditioned transformations.

Four new routines have been added. Their function is summarized below.

`SB10AD` computes the matrices of an H_∞ optimal state controller, using modified Glover's and Doyle's 1988 formulas.

`SB10MD` performs the D-step in the D-K iteration (continuous-time case).

`SB10YD` fits a supplied frequency response data with a stable, minimum phase SISO (single-input single-output) system represented by its matrices A, B, C, D.

`SB10ZP` transforms a SISO system $[A, B; C, D]$ by mirroring its unstable poles and zeros in the boundary of the stability domain, thus preserving the frequency response of the system, but making it stable and minimum phase.

The first two routines are user-callable.

The html documentation has also been updated for AB05ND, MB03RD, MB05MD, MB05MY, TB05AD, and TG01JD, according to the functional changes made, partly described above. The workspace for AB05ND for the option OVER = 'O', has been increased by N1*P1. Links to the new document files were made in the index files libindex and support.

Several M-files have been updated. Specifically, a test in slH2norm, slHknorm, and slinorm was made more general, to allow dealing with discrete-time ss systems with unspecified sampling time. The commands "clear all" and/or "clear variables" have been removed from all test files containing them (13 files), to avoid destroying the user data. Finally, descriptions for the new MEX-files and M-files have been added in the M-file Contents.

The MEX-files linorm and syscf have been updated. Standard systems (with E an identity matrix) may now be defined by setting E as an empty matrix (i.e., with 0 rows and/or columns), before calling linorm, to reduce the memory requirements.

Several new MEX-files and related M-files, listed below, have been added. For each item, the MEX-file is mentioned first, and then, the associated M-files are listed.

bldiag and bdiag perform block-diagonalization of a general matrix or a matrix in real Schur form.

condis performs a transformation on the parameters (A, B, C, D) of a system, which is equivalent to a bilinear transformation of the corresponding transfer function matrix. slc2d transforms a continuous-time system to a discrete-time system, and sld2c transforms a discrete-time system to a continuous-time system.

gsyscom transforms a descriptor system, by equivalence transformations, to a controllable or observable staircase form, or to a reduced (controllable, observable, or irreducible) form. The individual transformations mentioned above are performed by slgconf, slgobsf, and slgminr, respectively.

gsystra performs various equivalence transformations for descriptor systems with scaling, generalized Schur form, etc. The associated M-files slgsHes, slgsQRQ, slgsrsf, and slgsSVD transform the pair (A, E) of a descriptor system to: a generalized Hessenberg form, a QR- or RQ-coordinate form, a real generalized Schur form, and to a singular value decomposition (SVD) or SVD-like coordinate form, respectively, while slgsbal balances the system matrix for a descriptor system.

invert and sldual or slinv compute the dual or inverse of a linear (descriptor) system.

ldsimt and dsimt compute the output response of a linear discrete-time system. The input and output trajectories are stored column-wise (each column contains all inputs or outputs measured at a certain time instant).

slmexp computes the matrix exponential and optionally its integral; slexpm computes the matrix exponential using a diagonal Padé approximant with scaling and squaring, while slexpe tries first an eigenvalue/eigenvector decomposition technique, but switches to a diagonal Padé approximant with scaling and squaring, if the matrix appears to be defective; slexpi computes the matrix exponential and optionally its integral, using a Padé approximation of the integral.

sysconn computes a state-space model (A, B, C, D) for various inter-connections of two systems given in state-space form. Specifically, slfeed, slpar, slser, and slspar perform feedback, parallel, series, and rowwise inter-connection of two systems, while slapp appends two systems.

sysfconn and the associated slofeed and slosfeed, compute, for a given state-space system (A, B, C, D), the closed-loop system (A_c, B_c, C_c, D_c) corresponding to the output, or mixed output and state, feedback control law.

Associated help and test files have been also made available on the SLICOT ftp site. Details are given in the file Release.History.

The *SLICOT Library update on January 3, 2004*, included changes in several routines and associated interfaces. The updated Fortran routines are: AB01ND, AB01OD, AB08MD, AB08ND, AB09JV, AB09JW, FB01QD, FB01RD, FB01SD, FB01TD, FB01VD, MB02MD, MB02ND, MB03MD, SB08CD, SB08ED, SB10MD, SB10YD, SG03BX, TB01UD, TB01ZD, TB05AD, and TG01HX, from the SLICOT Library chapters A, F, M, S, and T. The bugs have been found and fixed while performing detailed testing using the newly developed MEX-files (see below). The updates mainly consisted in defining more restrictive conditions for performing some calculations, for instance for zero dimensions. Specific changes are, e.g., in SG03BX, in which the in-line calculation of the eigenvalues of the 2×2 pencil $A - \lambda E$ has been replaced by a call to the LAPACK Library routine DLAG2, and a bug in the normalization of the $(2, 2)$ entry of the upper triangular factor in the QR factorization of B has been fixed. Other details are given in the file Release.Notes.

Several improvements have been performed in the SLICOT routines FB01RD, FB01TD, MB02ND, and SB06ND. Specifically, the routines FB01RD and FB01TD now also work for P > N and M > N, respectively; the necessary workspace length was somewhat reduced in MB02ND, and the code SB06ND was slightly changed to allow the computation of the minimum norm feedback matrix also when the uncontrollable part of the system is zero.

The html documentation has also been updated for AB08ND, FB01QD, FB01RD, FB01SD, FB01TD, FB01VD, MB02MD, and MB02ND, according to the functional changes made, partly described above.

Several new MEX-files and related M-files have been added.

cfsys and cf2ss construct the state-space representation of a system from the factors of its left or right coprime factorization.

deadbeat and deadbt construct the minimum norm feedback matrix performing “deadbeat control” on an (A, B)-pair, and ckstair checks that a system is in a staircase form.

Kfiltupd computes a combined measurement and time update of one iteration of the Kalman filter.

polezero computes the normal rank, poles, zeros, and the Kronecker structure of the system pencil for a standard or descriptor system. Related M-files return specific results. Specifically, nrank computes the normal rank of the transfer-function matrix of a standard system; polzer computes the normal rank, poles, zeros, and the Kronecker structure of the system pencil for a standard or descriptor system; slpole computes the poles of a standard or descriptor system; and slzero computes the normal rank, zeros, and the Kronecker structure of the system pencil for a standard or descriptor system.

`specfact` and `polysf` compute the spectral factorization of a real polynomial.

`TotalLS` and `TLS` solve the Total Least Squares (TLS) problem using a singular value decomposition (SVD) approach or a Partial SVD (PSVD) approach.

Associated help and test files have been also made available on the SLICOT ftp site. Details are given in the file `Release.Notes`.

2.3 New NICONET Reports

A new NICONET report (available after July 2003), that can be downloaded as a compressed postscript file from the World Wide Web URL

`http://www.win.tue.nl/niconet/reports.html`

is the following:

- Asparuh Markovski, Petko Petkov, Da Wei Gu, Mihail M. Konstantinov. *Fortran 77 routines for μ-synthesis and H_∞ design* (file `SLWN2003-1.ps.Z`, January 2004).

  A set of Fortran 77 subroutines aimed to perform μ-synthesis procedure via DK iterations or H_∞ design alone is presented. The software is intended for linear, time-invariant, continuous-time systems, but it handles also discrete-time systems via bilinear transformation. The methods for μ-synthesis and H_∞ design implemented in the routines are briefly described. The subroutines make use of LAPACK and BLAS libraries and can be easily implemented from MATLAB by a MEX-file. The subroutines are included in the SLICOT library.

Previous NICONET/WGS reports are also posted at the same address.

2.4 Forthcoming Conferences

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

- The 12th Mediterranean Conference on Control and Automation MED'04, June 6-9, 2004, Kusadasý, Turkey.
- 16th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2004), July 5-9, 2004, Katholieke Universiteit Leuven, Belgium
- IFAC Workshop on Adaptation and Learning in Control and Signal Processing (ALCOSP 2004), and IFAC Workshop on Periodic Control Systems (PSYCO 2004), August 30–September 1, 2004, Yokohama, Japan.

Vasile Sima