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NICONET Newsletter

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1 Editorial

Welcome to the thirteenth 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. However, this proposal has not been approved. On July 7 we organized a NICONET meeting during the MTNS 2004 symposium which was held in Leuven, July 5-9, and decided to continue our efforts and explore other ways of EU funding.

We are pleased to announce that a special issue of the IEEE Control Systems Magazine (editor Andras Varga, IEEE Fellow) appeared in February 2004 which was entirely devoted to "Numerical awareness in Control" and which contained the following contributions of the NICONET team members:

1. Andras Varga, *Numerical Awareness in Control*. pp. 14-17.
2. Paul Van Dooren, *The Basics of Developing Numerical Algorithms*. pp. 18-27.
3. Nicholas J. Higham, Mihail Konstantinov, Volker Mehrmann and Petko Petkov, *The sensitivity of Computational Control Problems*. pp. 28-43.
4. Peter Benner, *Solving Large-Scale Control Problems*. pp. 44-59.
5. Sabine Van Huffel, Vasile Sima, Andras Varga, Sven Hammarling and François Delebecque, *High-Performance Numerical Software for Control*. pp. 60-76.

We invite you to read these papers in order to learn all aspects of the SLICOT library! Another important announcement is that several SLICOT components are now used in the updated version of the *Control System Toolbox* of MATLAB 7 (Release 14), distributed in June 2004. Specifically, the main changes made in this toolbox are summarized as follows (we cite from page 16 of the document MATLAB *& Simulink Release Notes for Release 14*):

- Overhauled numerical engine based on the LAPACK and SLICOT libraries for improved speed and accuracy
- Better model reduction algorithms with support for unstable models
- New commands for modal decompositions.

The SLICOT Library is now acknowledged on the second page of the Section "MATLAB Software Acknowledgments" of the mentioned document. 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 January 2004–July 2004

There has been one major SLICOT Library update during the period January 2004–July 2004: on April 14, 2004. Details are given in the file `Release.Notes`, located in the subdirectory `SLICOT/`, of the SLICOT ftp site.

The *SLICOT Library update on April 14, 2004*, included a lot of small changes in several routines and associated interfaces. Bugs have been discovered and fixed in the following Fortran routines: `MB01RD`, `MB01RU`, `MB01RX`, `MB02CU`, `MB02CV`, `MB02FD`, `MB02ID`, `MB02JD`, `MB02JX`, `MB02KD`, `TB01PD`, `TG01AD`, and `TG01JD` from the SLICOT Library chapters M and T. Some updates essentially consisted in defining more restrictive conditions for performing some calculations, especially for dealing with matrices with zero dimensions. Other changes refer to the (optimal) workspace length, added argument tests, or setting some output arguments for quick return. The most important changes were made in `MB02CU`, `MB02CV`, and `TG01AD`, where three wrong array references have been fixed. Details are given in the file `Release.Notes`.

Several calls (most often with negative increments) to Level 1 BLAS routine `DCOPY` have been replaced with in-line `FOR` loops, to avoid possible overwritting when using optimized BLAS libraries. Specifically, such changes have been performed in the following routines (see `Release.Notes`, for details) belonging to the chapters A, F, I, M, N, S, and T of the SLICOT Library: `AB05MD`, `AB05ND`, `AB05PD`, `AB05QD`, `AB05RD`, `FB01SD`, `FB01TD`, `IB01MD`, `IB01ND`, `IB03AD`, `IB03BD`, `MB02DD`, `MB02MD`, `MB02ND`, `MB05MD`, `MB05MY`, `MD03BD`, `NF01BP`, `NF01BS`, `SB01BD`, `SB01BX`, `SB03OT`, `SG03BD`, `TB01VD`, `TB01VY`, `TB04BV`, and `TB04BW`.

All Fortran and MATLAB tests have been redone using a library version built with the debug option activated. Several routines, listed below, have been changed in order to avoid exceeding array bounds. While this could previously happen, no memory writting action was actually performed, but just wrong references to array elements in the calls were sometimes possibly made. The list of modified routines is: `AB01ND`, `AB05MD`, `AB05OD`, `AB05PD`, `AB05QD`, `AB07MD`, `AB08ND`, `IB01RD`, `MA02CD`, `MB02CD`, `MB02CU`, `MB02CV`, `MB02CX`, `MB02CY`, `MB02DD`, `MB02ED`, `MB02FD`, `MB02GD`, `MB02HD`, `MB02JX`, `MB02ND`, `MB02UV`, `MB03VY`, `TB01XD`, and `TB01YD` from chapters A, I, M, and T. Some updates consisted in defining more restrictive conditions for performing some calculations, especially for dealing with matrices with zero dimensions. For instance, calls to certain BLAS or LAPACK auxiliary routines containing references to subarrays are now made only if the corresponding dimensions are nonzero; other calls are made such that

the array bounds are not exceeded. Some changes are related to the quick return section of some codes. For instance, the transposition of D in TB01XD was moved before the Quick return section, so that D is modified even if N = 0. It is worth mentioning that in many cases, there were no indication of errors, but the mentioned changes increase the reliability.

The html documentation has been slightly updated for MB02CV, MB02CX, MB02GD, MB02HD, MB02JD, MB02JX, MB02KD, MB02FD, TG01ID, and TG01JD.

Two test M-files, test_persch and test_polezero have been updated. The changes in the first file concern the tests when only the eigenvalues between specified values ilo and ihi are computed. The descriptions for the new MEX- and M-files have been added in the M-file Contents.

The calls of the BLAS routine DCOPY with negative increments have been replaced by suitable FOR loops in the MEX-files gsyscom, invert, sysconn, and TotalLS.

A new MEX-file muHopt and related M-files have been added. The MEX-file muHopt computes either the μ optimal or H_∞ controller. The M-file slihinf computes the H_∞ optimal controller, while slimju computes the μ optimal controller, given a state space model. In addition, slimju computes the μ norm of the closed loop system. Associated help and test files have been also made available on the SLICOT ftp site. Details are given in the file Release.Notes.

Several pages of the local NICONET Web page have been updated between January and July 2004, and the page activated by the hyperlink SLICOT software enables to download additional, easy-to-use SLICOT-related software and interface functions.

It is planned that the next SLICOT updates will include:

- M-files for Kalman filter updates. (The MEX-file is already available.)
- MEX-file(s) and M-files for conversions between system representations.
- new codes developed by Daniel Kressner for computing the eigenvalues and symplectic QR and URV/periodic Schur decomposition of Hamiltonian matrices (blocked and unblocked versions and related routines).
- Kawelke's codes.

2.3 New NICONET Reports

There were no new NICONET reports posted between January and July 2004. All available NICONET/WGS reports may be downloaded as compressed postscript files from the World Wide Web URL

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

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:

- 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