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NICONET Newsletter

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1 Editorial

Welcome to the eleventh 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. However, the maintenance and further development of the SLICOT library will be guaranteed by our international society, also called NICONET, which is operational since September 2001. Any funding received through this society will be used for the further development of the SLICOT library, as well as for the promotion and dissemination of the SLICOT software.
Section 2 briefly presents *The 11th Mediterranean Conference on Control and Automation, MED'03*, Rhodes, Greece, June 18–20, 2003. Section 3 describes the sessions proposed by NICONET and accepted for *The 7th European Control Conference, ECC03*, University of Cambridge, UK, September 1–4, 2003. Finally, Section 4 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 The 11th Mediterranean Conference on Control and Automation, MED'03, Rhodes, Greece, June 18–20, 2003

The *11th Mediterranean Conference on Control and Automation, MED'03*, was held in Rhodes, Greece, in June 18–20, 2003. The Conference was partially sponsored by Mediterranean Control Association (MCA), European Union (project ADACIE), EADS-3SIGMA S.A., National Technical University of Athens, Technical University of Crete, University of Zagreb, and University of Texas at Arlington. Technical sponsors were The IEEE Robotics and Automation Society and The IEEE Control Systems Society. Several tutorial workshops were held on June 17: *Workshop on Unmanned Aerial Vehicles*, *Tutorial on Robust Control* and *Tutorial on Microelectromechanical Systems (MEMS).*

Over 200 regular papers have been presented during the conference, grouped into 40 sessions; over 60 other papers were accepted in 12 invited sessions. The sessions run in four parallel tracks. In addition, several plenary talks were given by leading experts in the automatic control field: *Opportunities for Embedded Systems and Controls in the 6th European Research Framework Programme 2003–2006* (Dr. A. Konstantellos), *Control of Networked Embedded Systems* (Prof. P.J. Pardalos), *Advances in Robotics and Mechatronics—from Space to Surgery* (Prof. G. Hirsinger), *Supervisory Control* (Prof. W.M. Wonham) and *Hybrid Systems—A Control Engineering Perspective* (Prof. M. Morari).

The conference was well organized and well attended. The Proceedings on CD-ROM were made available to the conference participants. Besides the technical program, the charming Social Events included Welcome Reception, Conference Dinner, and Farewell Reception.

The NICONET participation in the MED'03 conference included two papers presented by V. Sima, entitled *Solving Algebraic Riccati Equations with SLICOT* (authors P. Benner and V. Sima) and *Identification of a Steel Subframe Flexible Structure Using SLICOT System Identification Toolbox* (author V. Sima). These papers were included in the Invited Session **IV01** on *Computational Toolboxes in Control Design*, organized by prof. A.I. Vardulakis and prof. N.P. Karampetakis. The session was held on Thursday, June 19, 8:30 – 10:15. The planned papers for the session IV01 were:

1. Peter Benner (Institut fur Mathematik, Berlin, Germany) and Vasile Sima (National Institute for Research & Development in Informatics, Bucharest, Romania), *Solving Algebraic Riccati Equations with SLICOT.*

2. Artur Gramacki, Jaroslaw Gramacki, Krzysztof Galkowski (Univ. of Zielona Gora, Poland), Eric Rogers (Univ. of Southampton, UK), David H. Owens (Univ. of Sheffield, UK), *A Matlab based Toolbox for Differential Linear Repetitive Processes.*

3. J. W. Helton (University of California, USA) and M. C. de Oliveira (University of Campinas, Brazil), *Doing systems and control with NCAlgebra, a symbolic noncommutative algebra toolbox.*

4. Neil Munro (University of Manchester Institute of Science and Technology, England), *A polynomial control systems package.*

5. Miguel Delgado Pineda (UNED, Facultad de Ciencias, Madrid, Spain) and Efim A. Galperin (Universite du Quebec a Montreal, Canada), *Nonconvex nonsmooth global optimization by the cubic algorithm: a MAPLE code.*

6. R. Prokop, R. Matusu, Z. Prokopova (Tomas Bata University in Zlin, Czech Republic), *Matlab environment for control of time-varying systems.*

7. Vasile Sima (National Institute for Research & Development in Informatics, Bucharest, Romania), *Identification of a steel subframe flexible structure using SLICOT system identification toolbox.*

8. A.I. Vardulakis, N. P. Karampetakis, E. Antoniou, S. Vologiannidis and P. Tzekis (Aristotle University of Thessaloniki, Greece), *A descriptor systems package for Mathematica.*

All papers, except paper 3, have been presented. The session was interesting and animated. Paper 1 presented SLICOT algebraic Riccati equations solvers and showed their improved performance in comparison with MATLAB solvers for both randomly generated examples and benchmark examples. Paper 7 illustrated the beneficial use of the SLICOT fast algorithms for identification of a challenging application from the DAISY collection (freely available from the Web page `http://www.esat.kuleuven.ac.be/sista/daisy`), with 8523 samples, 2 inputs and 28 outputs. All papers clearly indicated the current trend to use high-level software tools, based on MATLAB, Maple, or Mathematica.

It can definitely be said that the MED'03 conference was a remarkable scientific event.

Acknowledgment: Dr. Sima received a partial financial support from European Union funds for participation in the MED'03 Conference; this support covered the conference fee. The other expenses were partially supported by the National Institute for Research & Development in Informatics, Bucharest (Research grant PN 03 13 01 01).

Vasile Sima

3 NICONET participation in The 7th European Control Conference, ECC03, University of Cambridge, UK, September 1–4, 2003

Two sessions proposed by NICONET members have been accepted for *The 7th European Control Conference, ECC03*, University of Cambridge, UK, September 1–4, 2003:

- The Tutorial workshop *Advanced Computational Tools for CACSD*, organized by Peter Benner and Paul Van Dooren, and scheduled for Tuesday, September 2, 10:30 – 12:30 (Technical Session 2);
- The special session *Matrix Equations in Systems and Control*, organized by Peter Benner and Vasile Sima, and scheduled for Tuesday, September 2, 14 – 16 (Technical Session 3).

These sessions are described below.

Tutorial workshop "Advanced Computational Tools for CACSD"

organized by *Peter Benner and Paul Van Dooren*

AIMS AND TOPIC

With the ever-increasing complexity of control systems, efficient computational methods for their analysis and design are becoming more and more important. These computational methods need to be based on reliable and robust numerical software provided by well-tested and user-friendly software libraries.

This mini-course is intended as a tutorial on recent developments in advanced reliable and efficient computational method for solving analysis and synthesis problems of modern and robust control. Moreover, the importance of providing corresponding software implementations is demonstrated using the freeware Subroutine Library in Systems and Control Theory (SLICOT) for solving practical control engineering problems within CACSD environments. 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 like the MATLAB Control Toolbox. The SLICOT software library and the related CACSD tools based on SLICOT were developed within the *Numerics in Control Network (NICONET)* funded by the European Community BRITE-EURAM III RTD Thematic Networks Programme. We will present some of the activities within NICONET and introduce SLICOT-based software to be used either within MATLAB and the MATLAB Control Toolbox or the CACSD package Scilab.

Major topics of the course are *basic control software*, *system identification*, *model reduction*, and *robust control design using* H_∞ *techniques*.

The course will be particularly interesting for advanced graduate students and young researchers in systems and control theory who are engaged in the solution of practical control problems.

PROGRAM

The course will consist of 5 lectures:

1. **Paul Van Dooren:** *Introduction to NICONET and SLICOT*

   The aims and scope of the European thematic network NICONET will be presented. The requirements of robust numerical software for solving control engineering problems will be emphasized. Moreover, the contents and structure of the software library SLICOT and the embedding of SLICOT-based CACSD tools in user-friendly environments like MATLAB and Scilab will be discussed.

2. **Peter Benner:** *Basic control software*

   This part covers some basic computational problems underlying many control problems like system analysis (e.g., computing controllability/observability normal forms), solving linear and quadratic matrix equations, (e.g., Lyapunov, Sylvester, and Riccati equations arising in system stabilization, observer design, or optimization of linear control systems), or system norm calculations.

3. **Vasile Sima:** *System identification using subspace methods*

   System identification means finding mathematical models of dynamic systems from measured data. This is the first, and basic step for both system analysis and control system design. The talk will mainly address linear and Wiener-type systems in the multivariable case. The algorithms discussed are based on subspace methods (MOESP and N4SID) for the linear part and a neural network approach for the nonlinear part. Efficient and reliable implementations of these methods are available through the SLICOT-based toolbox SLIDENT.

4. **Andras Varga:** *Model and controller reduction*

   Model reduction has become a standard tool in various control system analysis and design applications, ranging from simulation of highorder systems to simplification of large order plant models for efficient evaluation of design criteria in multidisciplinary optimization-based controller tuning. The talk focuses on methods underlying the numerical software for model and controller reduction available in SLICOT. We discuss absolute error model reduction methods such as the balanced truncation, singular perturbation approximation, and Hankel norm approximation, their frequency-weighted counterparts, as well as relative error methods based on balanced stochastic truncation. Designing low order controllers for practical applications involving high order plants is a challenging problem where model reduction techniques often play an important role. To perform controller reduction, special techniques capable to address closed-loop stability and performance preservation aspects are required. We discuss the newest algorithmic developments for controller reduction for which robust numerical software is available in SLICOT.

5. **Da-Wei Gu:** *Robust control design using H_∞ methods*

   As control systems are vulnerable to external perturbations and measurement noise, robust control design methods aim at computing controllers that stabilize the given plant and guarantee certain performance levels in the presence of disturbance signals, noise interference, unmodeled plant dynamics, and model uncertainties. H_∞-optimization has become a standard method in this area, but its implementation in a CACSD environment is challenging due to several subtle numerical aspects. In this talk, reliable tools for H_∞-optimization, H_∞-loop shaping design, and μ-synthesis, available in SLICOT based toolboxes for MATLAB and Scilab, will be discussed.

The talks will be accompanied by online demonstrations demonstrating the application of the advanced computational methods discussed in this course to practical control problems.

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Special Session on "Matrix Equations in Systems and Control"

organized by Peter Benner[1] and Vasile Sima[2]

Since the epochal discoveries of Kalman in the early Sixties, matrix equations have played a fundamental role in systems theory, control, filtering and estimation. The algebraic Riccati equation provides the tool to solve the linear-quadratic regulator problem and to find the stationary Kalman filter. Combined, the solution of the linear-quadratic Gaussian control problem is obtained. Also, linear matrix equations such as Sylvester and Lyapunov equations occur in many analysis and design methods for linear and nonlinear control systems, e.g., in observer design, model reduction, or stabilization. As new control methodologies emerged in the early Eighties, like H_2- and H_∞-control, still the major work horse in computing the associated optimal or suboptimal controllers was found to be the algebraic Riccati equation; the H_2 norm of a system is computed via solving a Lyapunov equation, and there are numerous other applications.

As new design and modeling strategies evolve, like the use of periodic systems, hybrid systems, or differential games, new aspects and variants of matrix equations are discovered. This special session aims at bringing together researchers that investigate several aspects of these matrix equations arising in control and estimation problems. This comprises theoretical aspects like the solution behavior as well as the often-neglected numerical methods to solve these equations. Moreover, two of the six talks will be devoted to the central part that matrix equations play in balancing techniques for model reduction.

The following talks are planned for this special session:

1. **Daniel Kreßner**[3]: *Large Periodic Lyapunov Equations: Algorithms and Applications*
2. **Gerhard Freiling**[4] , Gerhard Jank, Dirk Kremer: *Solvability Condition for a Non-symmetric Riccati Equation Appearing in Stackelberg Games*
3. **Ralph Byers**[5] and Peter Benner: *A Structure-Preserving Method for Generalized Algebraic Riccati Equations Based on Pencil Arithmetic*
4. **A.C. Antoulas**[6] and S. Gugercin: *A Survey of Balancing Methods for Model Reduction*
5. **Dan C. Sorensen**[7]: *Passivity Preserving Model Reduction via Interpolation of Spectral Zeros*
6. **Vasile Sima**[2] and Peter Benner: *Solving Linear Matrix Equations with SLICOT*

Peter Benner

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4 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.

Additional information about the NICONET Thematic Network can be found from the NICONET homepage World Wide Web URL

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

4.1 Electronic Access to the Library

The 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. It is possible to browse through the documentation from the NICONET page location

`http://www.win.tue.nl/niconet/NIC2/slicot.html`

The SLICOT index is operational there. Each functional "module" can be copied to the user's current directory, by clicking on an appropriate location in the `.html` image. 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.

The entire library is contained in the file `slicot.tar.gz` from `pub/WGS/SLICOT/` directory. 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 available in the SLICOT root directory mentioned above; it contains the MS-DOS version of the source codes of the SLICOT Library, and can be used on Windows 9x/2000/ME 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.

4.2 SLICOT Library updates in the period January 2003–July 2003

There has been one major SLICOT Library update during the period January 2003–July 2003: on March 27. Details are given in the file `Release.Notes`, located in the root directory, `pub/WGS/SLICOT/`, of the SLICOT ftp site.

The *SLICOT Library update on March 27, 2003*, included changes in several routines and associated interfaces. The updated Fortran routines are: `AB13BD`, `AB13ED`, `AB13FD`, `DF01MD`, `MA02HD`, `MB03SD`, `SB03QD`, `SB03SD`, and `SB10SD` from the SLICOT Library chapters A, D, M, and S. 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 the case $\mathtt{N} = 0$. Details are given in the file `Release.Notes`. It is worth mentioning here that `DF01MD` actually works for $\mathtt{N} \geq 5$ (and not $\mathtt{N} \geq 3$, as assumed before). Also, the option values `JOBSCL = 'P'` and `JOBSCL = 'B'` have been removed from `MB03SD`, since otherwise the Hessenberg form of the matrix `A''` would not be preserved. In addition, the efficiency of `MB03SD` has been improved by using calls to the BLAS 3 routine `DSYMM` as much as possible.

Several improvements have been performed in the SLICOT routines `SB02MD`, `SB02OD`, `SB02OY`, `SB02RD`, and `SG02AD`. Specifically, the scaling factor used in `SB02MD` and `SB02RD` (when `JOB = 'X'`), is now returned. It could be needed when a basis for the stable invariant subspace is computed. Internal scaling has been incorporated in `SB02OD`, to increase accuracy and reliability for poorly scaled equations. Moreover, the natural tendency of the QZ algorithm to get the largest eigenvalues in the leading part of the matrix pencil is now exploited for discrete-time Riccati equations, by computing the unstable eigenvalues of the permuted matrix pencil. (This has been also implemented in `SG02AD`.) In addition, a standard eigenproblem is solved for continuous-time equations when the matrix G is given (`JOBB = 'G'`). Finally, the extended matrix B_f is not built (and significant memory is saved) in `SB02OY` for continuous-time problems with G given and identity matrix E, since a standard eigenproblem is solved in this case.

The `html` documentation has also been updated for `DF01MD`, `MB03SD`, `SB02MD`, `SB02OD`, `SB02OY`, `SB02RD`, and `SG02AD`, according to the functional changes made, partly described above. Moreover, on-line `html` documentation files have been added for some SLICOT interfaces to various nonlinear solvers, namely `DAESolver`, `ODESolver`, `FSQP`, and `KINSOL`, and links to the new document files were made in the index file `libindex`.

Several M-files (`slcaregs`, `slcares`, `slcaresc`, `sldaregs`, `sldaregsv`, `sldares`, and `sldaresc`), the MEX-files `aresol` and `aresolc`, and the associated test files have been updated. The scaling factor used is now returned when a basis for the stable invariant subspace is computed.

All test functions for SLICOT MEX-files and M-files have been run under MATLAB 6.5. This required changes in several functions for model and controller reduction, to avoid the local variable discr being interpreted as a logical array. The changed functions are bst, bta, btabal, btabal_cf, bta_cf, cfconred, fwbconred, fwbred, fwhna, hna, lcf, lcfid, rcf, rcfid, spa, spabal, spabal_cf, spa_cf, and test_conred. These functions have been successfully re-checked under MATLAB 5.3 and 6.1.

Executable MEX-files for MATLAB 6.5 on Windows platforms have been generated and made available on the SLICOT ftp site (file dllfiles65.zip, subdirectory SLTools). These MEX-files are significantly smaller than the corresponding MATLAB 6.1 MEX-files.

Several new MEX-files and related M-files have been added. The MEX-file arecond and the M-files carecond, darecond, lyapcond, and steicond estimate the reciprocal condition number and forward error bounds for continuous-time and discrete-time algebraic Riccati and Lyapunov equations. The MEX-file garesol and the M-files slgcare and slgdare solve continuous-time and discrete-time descriptor algebraic Riccati equations. The MEX-file datana and the M-files sincos, slDFT, sliDFT, slHart, slconv, sldeconv, and slwindow perform various data analysis calculations: sine or cosine transform of a real signal, discrete Fourier transform of a signal, inverse discrete Fourier transform of a signal, discrete Hartley transform of a real signal, convolution of two real signals using either FFT or Hartley transform, deconvolution of two real signals using either FFT or Hartley transform, and anti-aliasing window applied to a real signal, respectively. The MEX-file Hessol and the M-files Hesscond and Hessl perform analysis (estimating the reciprocal of the condition number) and solution of a system of linear equations with an upper Hessenberg coefficient matrix. The MEX-file Hnorm and the M-files slH2norm, slHknorm, and slstabr compute the H2/L2 norm, the Hankel norm of a stable projection of a system, and the complex stability radius, respectively. Finally, the MEX-file Hamileig and the M-file Hameig compute the eigenvalues of a Hamiltonian matrix using the square-reduced approach.

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

Several M-files, originally written by prof. Andre L. Tits and his collaborators (Craig T. Lawrence, and Yaguang Yang), including the μ-norm computation files (munorm, test_scalar, test_mixed, and test_complex) and robust pole assignment files (robpole, complex_pair, real_pair, and one_column), have been analyzed, some bugs were found and communicated to the authors, and then removed. Also, some improvements have been proposed and operated. These files are archived in the subdirectory MatlabTools/contrib.

All compressed files (tar.gz and zip) have been updated for the changes and additions performed.

Changes performed since March 27, 2003, which will be incorporated in the next SLICOT Library update, include:

- All bugs found when testing the new MEX- and M-files (see below) have been fixed. Specifically,

  AB13DD: The permutations for the balancing transformations on B and C are now correctly applied.

  MB05MD, MB05MY: The backward transformation of the eigenvectors for balancing (when BALANC = 'S') was moved from MB05MY to MB05MD, since it must be done after pre-multiplication with the orthogonal matrix performing the reduction to real Schur form. The scaling is also used when computing the inverse of the matrix V, and the scaling factors are stored in DWORK(2), ..., DWORK(N+1).

MB05OD: RERL is set to 0 when SIZE $\leq$ EMNORM.

SB01BD: Few suitable statements were added after the call of SB01BY, when a simple 1×1 block is uncontrollable.

SB01BY: Several possible divisions by 0 are avoided.

SB08CD, SB08ED: The code in the "Quick return" part was changed, so that the calculation continues appropriately if $M = 0$, but $\min(N, P) > 0$, delivering the result for a system (A, C) (with no inputs).

SB08DD, SB08FD: Similarly, if $P = 0$, but $\min(N, M) > 0$, delivering the result for a system (A, B) (with no outputs).

SB08FD: INFO on exit from SB01BY is now checked, since, due to roundoff, an uncontrollable 2×2 block could appear, which actually corresponds to a double real eigenvalue; one eigenvalue is then eliminated, and the procedure restarted. Such a block was not previously removed.

TF01MD, TF01ND: The computation of the output vectors when $n = 0$ (the non-dynamic system case) is now done correctly.

TG01AD: LSCALE or RSCALE is set to 1 in the "Quick return" sequence, if $L > 0$ but $N = 0$, or $L = 0$ but $N > 0$, respectively.

TG01CD: The call of DORMQR for updating B is made only if $M > 0$.

TG01AD, TG01ED, TG01FD, TG01HX: The calling statements containing indexed references to the arrays B and/or C are now not executed if $M = 0$ and/or $P = 0$, so that B and/or C can have 0 length.

TG01JD: The leading dimensions N, M, and P in the calls of DLACPY have been replaced by MAX(1,N), MAX(1,M), and MAX(1,P), respectively.

- The subroutine MB03RD has been improved by adding two new options, SORT = 'C' and SORT = 'B', which allow a "closest-neighbour" strategy to be used for selecting the block to be added to the current block for block diagonalization. The previous options SORT = 'N' and SORT = 'S' 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. The closest-neighbour strategy was suggested by Pascal Gahinet. Quick return (for N = 0) has been included.

- Several M-files and MEX-files have been updated. Specifically,

  - The test "if Ts > 0" has been replaced in slH2norm, slHknorm, and slinorm by "if Ts ~= 0", to allow dealing with discrete-time ss systems with unspecified sampling time.
  - The commands clear all or clear variables have been deleted in the test files test_aresol, test_aresolc, test_conred, test_datana, test_Hessol, test_Hnorm, test_genleq, test_linmeq, test_syscf, test_syscom, test_systra, test_sysred, and test_sysred_tools, to avoid destroying the user data.
  - Standard systems (with E an identity matrix) may now be defined in the MEX-file linorm by setting E as an empty matrix (i.e., with 0 rows and/or columns), in order to reduce the memory requirements. The associated test file, test_linorm, has been updated accordingly, for testing this new option (for standard systems).

  - The M-file `Contents` includes the descriptions for the new MEX-files and M-files. It is also mentioned there that sparse matrix format is not currently supported.

  Other details are given in the file `Release.Notes`.

- New MEX-files and associated M-files have been written.

  - The MEX-file `bldiag` and the M-file `bdiag` perform block-diagonalization of a general matrix or a matrix in a real Schur form.
  - The MEX-file `ldsimt` and the M-file `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).
  - The MEX-file `slmexp` and the M-files `slexpe`, `slexpm`, and `slexpi` compute the matrix exponential and optionally its integral. Specifically, `slexpe` and `slexpm` compute the matrix exponential; `slexpm` uses a diagonal Padé approximant with scaling and squaring, while `slexpe` uses basically an eigenvalue/eigenvector decomposition technique, but switches to the Padé technique above, if the matrix appears to be defective; `slexpi` computes the matrix exponential and optionally its integral, using a Padé approximation of the integral.
  - The MEX-file `gsyscom` and the M-files `slgconf`, `slgobsf`, and `slgminf` transform a descriptor system, by equivalence transformations, to a controllable or observable staircase form, or to a reduced (controllable, observable, or irreducible) form, respectively.
  - The MEX-file `gsystra` and the M-files `slgsbal`, `slgsHes`, `slgsQRQ`, `slgsrsf`, and `slgsSVD` perform various equivalence transformations for descriptor systems with scaling, generalized Schur form, etc. Specifically,

    `slgsbal` balances the system matrix for a descriptor system;

    `slgsHes` transforms the pair (A,E) to a generalized Hessenberg form;

    `slgsQRQ` transforms the pair (A,E) to a QR- or RQ-coordinate form;

    `slgsrsf` transforms the pair (A,E) to a real generalized Schur form;

    `slgsSVD` transforms the pair (A,E) to a singular value decomposition (SVD) or SVD-like coordinate form.

  Other new MEX- and M-files are under development, and they will be mentioned in the next issue of this Newsletter.

4.3 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 8th SIAM conference on Applied Linear Algebra, The College of William and Mary, Williamsburg, VA, U.S.A., July 16-19, 2003.

- The 13th IFAC Symposium on System Identification, SYSID 2003, August 27-29, 2003, Rotterdam, The Netherlands.

- The 7th European Control Conference ECC03, Sept. 1–4, 2003, University of Cambridge, UK. The NICONET participation in this conference includes the following accepted sessions (see details in Section 3 of this issue):
  - The Tutorial workshop *Advanced Computational Tools for CACSD*, organized by Peter Benner and Paul Van Dooren (with Paul Van Dooren, Peter Benner, Andras Varga, Vasile Sima, and Dawei Gu as lecturers), and scheduled for Tuesday, September 2, 10:30 – 12:30 (Technical Session 2);
  - The special session *Matrix Equations in Systems and Control*, organized by Peter Benner and Vasile Sima (with papers authored by Daniel Kreßner; Gerhard Freiling, Gerhard Jank, and Dirk Kremer; Ralph Byers and Peter Benner; A.C. Antoulas and S. Gugercin; Dan C. Sorensen; and Vasile Sima and Peter Benner), and scheduled for Tuesday, September 2, 14 – 16 (Technical Session 3).

Vasile Sima