First Control Training Site Workshop (1stCTSW)
Book of Abstracts

F. Silva Leite (Chair), M. Camarinha, M. Guerra, E. Rocha, D. Torres
http://www.mat.ua.pt/1ctsw

Department of Mathematics
University of Coimbra
1–3 July 2004

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4 Invited Speakers

- Agrachev, Andrei – SISSA, Italy
- Bicchi, Antonio – University of Pisa, Italy
- Cutland, Nigel – University of Hull, U.K.
- Jakubczyk, Bronislaw – Warsaw University, Poland
- Kawski, Matthias – Arizona State University, USA
- Lamnabhi-Lagarrigue, Françoise – C.N.R.S., France
- Martin, Philippe – École des Mines de Paris, France
- Sepulchre, Rodolphe – Université de Liège, Belgium
- Van der Schaft, Arjan – University of Twente, The Netherlands

5 Programme

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6 Chairmen

CH01	Agrachev, Andrei
CH02	Clemente-Gallardo, Jesus
CH03	Colonius, Fritz
CH04	Jakubczyk, Bronislaw
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CH11	Van der Schaft, Arjan
CH12	Zinober, Alan

7 Abstracts

Th 09:10-10:00 (Invited) – IS06

Some new results for the control of some nonlinear hybrid systems

Lamnabhi-Lagarrigue, Françoise

I will talk about the following topics.

- Lyapunov approach for nonlinear sample data systems
  Nonlinear sampled-data feedback control systems consist of the interconnection of a nonlinear plant (described by a system of first order ordinary differential equations) and a digital controller (described by a system of first order nonlinear difference equations) along with the interface elements (A/D and D/A converters). The analysis of a nonlinear sampled-data system is of great interest but has always been deduced by the analysis of the corresponding linearized sampled-data system. We here propose to directly consider the nonlinear system in order to study global stability property.

- MLD approach for switching systems
  The Mixed Logical Dynamic (MLD) form, introduced by Bemporad and Morari, is used here for deriving a robust controller for a class of nonlinear systems. The evolution of these systems is governed by linear dynamic equation subject to linear mixed integer inequalities involving binary and continuous variables. Binary variables represent the discrete-valued components and they are introduced according to logical inference techniques used in operations research. The key idea is to transform propositional logic statement into linear inequalities involving integer and continuous variables. The MLD contains several classes of hybrid systems like hybrid automata and piecewise linear systems (PWA). The control of this class of systems (PWA) is strongly facilitated by the equivalence between MLD form and PWA. In this work we use this equivalence to control a class of nonlinear switching systems. A robust controller is constructed by using discrete sliding mode theory and robustness properties are proven by using discrete time Lyapunov function.

- Viability approach for multi-model switching systems
  Viability theory is a powerful tool which enables to take into account several constraints (bounded inputs, state constraints...) in the design of controllers. We here propose to use this theory to address the problem of stabilizing nonlinear switching systems (without any state jumps). The control law is hybrid in the sense that it has discrete and continuous components. The discrete control law is a discrete event input which consists in choosing between a finite number of dynamics. The continuous control law is defined as usually. Although there are well-established techniques to design the low-level controllers (continuous control laws), the difficulty of dealing with hybrid systems is to mix them with the design of a discrete event supervisor. Our approach proposes a new stabilizing algorithm based on Viability Theory which enables to partition the state space in capture basins and then to deduce the discrete event supervisor. This approach also enables to build a lower semi-continuous extended function which enjoys a Lyapunov property.

Th 10:00-10:20 – TID56

Viability approach for multi-model switching systems

Burlion, Laurent

Viability theory is a powerful tool which enables to take into account several constraints (bounded inputs, state constraints...) in the design of controllers. We here propose to use this theory to address the problem of stabilizing nonlinear switching systems (without any state jumps). The

control law is hybrid in the sense that it has discrete and continuous components. The discrete control law is a discrete event input which consists in choosing between a finite number of dynamics. The continuous control law is defined as usually. Although there are well-established techniques to design the low-level controllers (continuous control laws), the difficulty of dealing with hybrid systems is to mix them with the design of a discrete event supervisor. Our approach proposes a new stabilizing algorithm based on Viability Theory which enables to partition the state space in capture basins and then to deduce the discrete event supervisor. This approach also enables to build a lower semi-continuous extended function which enjoys a Lyapunov property.

Th 10:20-10:40 – TID45

Towards the characterization of identifiability of discrete-time nonlinear systems

Nõmm, Sven

In the recent time input-output discrete-time models become popular for modelling real-life engineering systems and there are significant number of contributions devoted to the problem of parameter identification of discrete-time systems in the context of some specific engineering problem. Discrete-time systems are also well suited to study problems of digital telecommunications.

Compare to the continuous-time case, where identifiability question got extensive and systematic treatment identifiability of discrete-time systems did not got as much attention. Existing results are valid for some special classes of the systems and does not give the systematic treatment to the topic.

Answering the question wether or not the parameters of the system can be uniquely determined from the input-output data, identifiability has a crucial importance for the quality of the identification results. Surprisingly contributions in identification dramatically outnumber the contributions devoted to the problem identifiability. Surprisingly there huge number of contributions in identification, while the property of identifiability does not seen to be well studied.

The main goal of this paper is to give proper characterizations to the relations between the different concepts of identifiability for discrete-time nonlinear systems, using linear algebraic framework. It will be shown that, with suitable mathematical tools, results known for continuous-time nonlinear systems can be extended generically to the discrete-time case.

Th 11:10-12:00 (Invited) – IS04

Nonitegrable distributions and their singular curves

Jakubczyk, Bronislaw

Nonintegrable distributions appear as nonholonomic kinematic constraints (e.g. mobile robots), in termodynamics and in the geometric theory of differential equations. They are also defined by control-linear systems. The trajectories of such control systems which satisfy formally the Pontriagin Maximum Principle for the time-optimal Hamiltonian are called singular curves. We will discuss several remarkable features of singular curves. In particular we will show that these curves determine the distribution in most interesting cases, thus they entirely encode the geometry of the distribution. A car with several trailers will serve as mechanical example.

Th 12:00-12:20 – TID27

Computation of Time Optimal NMR Pulse Sequences for Two Spin Systems

Kleinsteuber, Martin

The development of control strategies for coupled spin systems is an important part of nuclear magnetic resonance (NMR) spectroscopy. The following two problems play a major role:

1. Characterize and compute the set of maxima of the transfer function of a coupled spin system.

2. Develop explicit time optimal control strategies, so-called pulse sequences, which steer a given spin system to a desired final state.

While the first problem can be expressed as a global optimization task on $SU(2^N)$, the second defines an optimal control problem. Time optimal pulse sequences are not only important in NMR experiments, but they are also an essential ingredient of NMR based quantum computation. Similar challenges arise in related areas such as inverse kinematics and robotics.
In this talk I examine in detail a system of two coupled spin-$\frac{1}{2}$ particles. In the first part the set of maxima of the transfer function is computed. In particular, it is shown that it decomposes in two connected components. If time allows, then in the second part a numerical algorithm is presented to explicitly construct time optimal pulse sequences that reach any final state. The proposed algorithm finds a pulse sequence that achieves the recently theoretically established optimal time.

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Th 12:20-12:40 – TID29

Newton's Algorithm in Euclidean Jordan Algebras, with Applications to Robotics

Ricardo, Sandra

We consider a convex optimization problem on linearly constrained cones in Euclidean Jordan algebras. The cost function consists of a quadratic cost term plus a penalty function. A damped Newton algorithm is proposed for minimization. Quadratic convergence to the global minimum is shown using an explicit step-size selection.

Th 14:40-15:20 (Invited) – IS05

Combinatorics and Geometry in Nonlinear Control

Kawski, Matthias

Explicit formulas for solutions (trajectories) of nonlinear control systems, usually written in infinite series form, can be almost as daunting to analyze and to manipulate as the original problem

they are supposed to solve. Examples are the Campbell-Baker-Hausdorff formula, the Chen-Flies series, Volterra series, and the Magnus expansion.

The rich noncommutative structure of the control vector fields provides the ability to simultaneously control many degrees of freedom with only one or a few control inputs. But this same structure also makes naive by-hand calculations almost impossible.
This talk will demonstrate how algebraic and combinatorial tools allow one to address otherwise practically intractable problems of analytic and geometric nature. Typical are the study of reachable sets, construction of approximating systems, and transformations to normal forms. In particular, we argue that one practically should never directly manipulate the iterated integral functionals that are so common in nonlinear control, usually involving repeated integration by parts. Instead such manipulations should almost always be carried out on a purely combinatorial level, using suitable functorial properties, most notably chronological, or Zinbiel algebra isomorphisms.

Th 15:20-15:40 – TID54

Curvature and Feedback Classification of 2-dimensional Control Systems

Serres, Ulysse

We will explain how the notion of Riemannian curvature of 2-dimensional surfaces can be extained to 2-dimensional optimal control systems giving a "bracket" definition of this invariant. The curvature tensor for non linear optimal control problems was already introduced by A. A. Agrachev and R. V. Gamkrelidze by means of Jacobi (curves in the Lagrangian Grassmannian). Here we will not deal with Jacobi curves but use the moving frame method in order to provide a "bracket" definition of the curvature function. Then we will see that the "control" analogue to Gaussian curvature reflects similar properties and give a partial feedback classification for systems under consideration.

Th 15:40-16:00 – TID42

Introduction to OreModules: Linear Systems over Ore Algebras

Robertz, Daniel

The study of linear control systems forms a great part of systems theory. Even if one restricts to the linear case, many types of equations show up in applications as for instance ordinary differential equations, partial differential equations, differential time-delay systems, discrete systems, repetitive systems...

We present an algebraic way to deal with all types of linear systems enumerated above (and more), which means to describe them in a unified way and give effective algorithms for their computational treatment. In this algebraic framework linear systems are represented by modules over certain rings of operators (the operators which occur in the system equations) which are called Ore algebras (McConnell, Robson, 2000). We demonstrate the correspondence of module properties to intrinsic properties of the system which in fact leads to a dictionary. Using homological algebra, the most interesting module properties can be checked effectively. We present algorithms that check, e.g., controllability, parametrizability, flatness and π-freeness (Fliess, Mounier, 1998).

The advantage of describing these properties in the language of algebra carries over to the part of implementation: up to the choice of the domain of operators which occur in a given system, all algorithms are stated and implemented in sufficient generality such that ODEs, PDEs, differential time-delay systems, discrete systems... are covered at the same time.

The Maple package OreModules (Chyzak, Quadrat, Robertz, 2004), whose development started during the author's CTS training period in 2003, is the first implementation of homological meth-

ods in this generality with regard to applications in linear control theory and especially for the computation of the parametrizations for multidimensional linear systems and the study of flatness. The case of linear systems with constant, polynomial, or rational coefficients can be coped with. The implementation of OreModules was enabled by the recent extension of Gröbner bases to Ore algebras (Chyzak, Salvy, 1998), so that OreModules is based on the library Mgfun.

Parametrizations and the concept of flatness have important applications to, e.g., motion planning, pole placement and optimal control. All the main results will be demonstrated in Maple using OreModules.

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Th 16:20-16:40 – TID46

The use of Separable Least Squares for the identification of composite state-space models

Borges, José

In this talk we will present a novel approach towards the identification of composite local linear state-space models from input-output measurements of a nonlinear dynamical system. This approach consists of the combined use of the separable least squares optimization principle with a projected gradient method for the estimation of model parameters. In this way, the method avoids to use a specific canonical parametrization for the state-space matrices, and is thus expected to lead to a better conditioned optimization problem. Composite local linear state-space models can be used to approximate nonlinear systems. Such an approximation can be interpreted as a division of the operating range of the nonlinear system into smaller regimes, in which the nonlinear system is approximated by a linear model. The weighted combination of all local models is, therefore, an accurate approximator for the nonlinear system. By means of Monte-Carlo simulation experiments we show that the use of the proposed method results in a reduced number of iterations for the optimization procedure while achieving an increase of the model accuracy.

Th 16:40-17:00 – TID20

Numerical Computation of Invariant Densities for Linear Stochastic Differential Equations

Matsikis, Iakovos

For the 3-D linear oscillator with damping and disturbed by multiplicative white noise, we numerically compute the unique invariant density of the associated system obtained by projection onto the unit sphere. We show how varying feedback gains and noise intensities affect the corresponding density and consequently the stability properties.

Th 17:00-17:20 – TID31

Modeling and Nonlinear Model Predictive Control of the product distribution of a FCCU

Raluca, Roman

The paper presents a dynamic simulator for a Fluid Catalytic Cracking Unit (FCCU). The model is developed for the reactor-regenerator section and includes a five lump kinetic model for the riser, which can describe the composition of the major product stream of the FCCU. The model is represented with a set of partial differential equations and gives the spatial and dynamic variation of the product distribution along the riser. The effects of different catalyst and raw material ratio on the composition of the products are assessed by a comprehensive sensitivity analysis. A set of FCCU dynamic simulations have been performed and the dynamic behavior of the system with respect to the product distribution is studied in the case of different upsets in manipulated variables and disturbances. The novel dynamic simulator is used to study different operating regimes. Dynamic simulations reveal the multivariable and nonlinear behavior of the process presenting strong interactions. The complex dynamic model of the industrial fluid catalytic cracking unit was used to implement the nonlinear model predictive control (NMPC) algorithm. A controllability analysis had been performed and different control schemes were tested, providing an assessment of the performance of the proposed advanced control algorithm, with respect to different disturbances and parameter uncertainties.

Th 17:20-17:40 – TID30

Using token leaky buckets for congestion feedback control in packets switched networks

Guffens, Vincent

A fluid flow model of an FCFS queueing system is presented and extended to the so-called token leaky bucket case. A simple feedback strategy that guarantees the boundedness of packets buffer queue is then introduced. Some simulations are presented and confronted to experiments run on a network made of Linux machines.

Th 17:40-18:00 – TID47

Modeling traffic systems with continuous Petri nets

Julvez, Jorge

Traffic systems are complex dynamical systems in which high populations may appear. One of the main drawbacks of highly populated discrete event systems is that they suffer from the state explosion problem. Thus, verification techniques based on exhaustive state exploration may become computationally prohibitive. A classical relaxation technique to deal with large discrete systems is to fluidify the model. This leads to macroscopic models whose goal is to simplify

analysis, control and simulation tasks. In terms of Petri nets, fluidification means that the amount in which a transition is fired is not in the naturals but in the positive reals. This way, the marking (state) of the net is also a vector of nonnegative real numbers. It will be shown that continuous Petri nets constitute a suitable analytical formalism to macroscopically model traffic systems. The obtained model is intuitive and highly compositional. Through hybrid Petri nets, discrete traffic elements such as traffic lights and other road sections can be modeled.

Th 18:00-18:30 (POSTER) – TID37

Using system theoretic tools for model discrimination in apoptosis

Cimatoribus, Carla

Apoptosis is a form of programmed cell death which enables multicellular organisms to remove unwanted cells, maintaining the proper balance between cell reproduction and death. It is therefore a strictly controlled process and a misregulation in apoptosis signalling can lead to cancerous cells, autoimmune deseases or developmental defects. A deep understanding and modelling of this system is therefore of great medical interest.
Despite the very scarce amount of experimental data, we can build various models for the single cell defined by nonlinear positive ODE systems (of increasing complexity from 6 to 10 states, from 10 to 13 parameters) with one major prerequisite: the structure of models must allow a bistable-behaviour region in the space of parameters and in this bistability region the parameters should fulfill the experimental requirements, approching the literature kinetic values. One of the few known experimental features of the real system is in fact the bistable behaviour: the cell must survive small impulses of apoptosis activating signal, but must succumb to a larger input. Moreover, biological systems are known to be robust: our first *discriminating criteria* among models is therefore the wideness of parameters ranges in which the above-mentioned requirements are accomplished.
Various methods and tools are then used in order to analyse the models: random simulations give a first assessment of the parameters values; through analytical analysis and constrained optimizations, we recognize that models may present a bistable behaviour only in a region of parameters space sensibly far from literature data. We validate these observations measuring models robustness, rating the number of parameters sets which fulfill the constraints out of the number of sets explored and obtaining a scaled and comparable number for each model. Other discriminating criteria are the predictivity in describing population behaviour, evaluated through statistical tools, and the measurability of model outputs: this last in particular has great influence in experimental design.

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Th 18:00-18:30 (POSTER) – TID36

Analyzing the Hierarchical Control of Escherichia coli Tricarboxilic Acid Cycle

Ofiteru, Irina Dana

Today Escherichia coli is the best characterized microorganism known to science and the work

with it has many advantages for molecular biologists. Living cells are extremely complex and can only be fully understood by using mathematical models. These can be made for the whole cell or for important parts of it. One central part of the metabolism is the tricarboxilic acid (TCA) cycle where the influence of different environmental conditions is integrated. The changes in the environment (aerobic/anaerobic, different kinds of substrate etc.) require a tremendous adaptation of the cell. Understanding the underlying regulatory mechanisms is the goal of our project.

The proposed model intents to explain, at a decisional level, the way several concurrent / complementary paths are selected. For this, the model includes the reactions of the TCA as well as a simplified model of operons, which are the basic elements (decision units) of genetic control. This is a hierarchical control structure with the reactions being roughly a hundred times faster than changes in the gene expression. The hierarchical modeling approach should allow to reproduce the ability of Escherichia coli to adapt to changes in the environment by regulating the expression of its genes to produce the optimal amount of intermediates and end products in the exactly due amount and only when needed, for efficient use of cellular resources.

The model consists of about 30 nonlinear ordinary differential equations and includes, beside the TCA intermediates, the paths to the end products, which can be used for parameter estimation and model validation. It is used for simulating different experimental conditions. To establish which parameters should be carefully determined from experiments, sensitivity analyses are carried out. The resulting model will allow to analyze the control strategies of Escherichia coli and elaboration of an optimal control policy for cell cultures.

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Th 18:00-18:30 (POSTER) – TID34

Linear and Nonlinear Model Predictive Control of a high purity distillation column

Urzica, Daniela

The paper provides a comparison case study between Nonlinear Model Predictive Control (NMPC) and Linear Model Predictive Control (LMPC). A brief summary of both the NMPC and the LMPC problem formulation is presented. A comprehensive assessment of the two categories of MPC is performed, with applications to a simulated distillation column. Both the output feedback and state feedback case are considered for LMPC and NMPC. Previous studies in the literature often compared state feedback NMPC with output feedback LMPC. In this paper these strategies are carefully compared and contrasted with respect to implementation complexity and computational burden. The simulation results demonstrate that it is not always clear when the advantages of NMPC over LMPC justifies the need of the latter, even in the case of this highly nonlinear processes. This stresses once again the need for a systematic approach that can provide guidelines in choosing the proper control strategy for a particular application.

Fri 09:10-10:00 (Invited) – IS09

Equivalence of dynamical systems

Van der Schaft, Arjan

A common theme in theoretical computer science (in particular, the theory of concurrent processes

and computer-aided verification) and in systems and control theory is to characterize systems which are 'externally equivalent'. The intuitive idea is that we only want to distinguish between two systems if the distinction can be detected by an external system interacting with these systems. This is a fundamental notion in design, enabling us to take a 'divide and rule' strategy, and in analysis, allowing us to switch between externally equivalent representations of the same system and to reduce sub-systems to externally equivalent but simpler sub-systems.

In computer science the crucial notion in this endeavor is the concept of bisimulation which expresses when a sub-process can be considered to be externally equivalent to another (hopefully simpler) process. On the other hand, classical notions in systems and control theory are state space equivalence of dynamical systems, and reduction of a dynamical system to an equivalent system with minimal state space dimension. These notions have been instrumental in e.g. linking input-output models to state space models, and in studying the properties of interconnected systems.

Developments in both areas have been rather independent, one of the reasons being that the mathematical formalisms for describing both types of systems (discrete processes on the one hand, and continuous dynamical systems on the other hand) are rather different. However, with the rise of interest in hybrid systems, which are systems with interacting discrete and continuous dynamics, there is a clear need to bring these theories together.

In this talk we will show how the notion of bisimulation for concurrent processes can be extended to continuous dynamical systems, and how the developed notion unifies the concepts of state space equivalence and reduction and allows to study equivalence of non-minimal dynamical systems. The key tool in this theory is the notion of controlled invariance from linear and nonlinear geometric control theory.

Next we will study bisimulation of systems with a distinguished structure, such as Hamiltonian and passive systems, and show how in these cases the (maximal) bisimulation relation has special properties (co-isotropic, Lagrangian, ..) intimately related to the underlying geometry.

Finally we will discuss how the notion of bisimulation for continuous systems can be merged with the standard notion of bisimulation for concurrent processes in order to obtain a structural bisimulation notion for general hybrid systems.

Fri 10:00-10:20 – TID49

Non-Minimum Phase Control Systems (with Zhivko Stoyanov)

Zinober, Alan

Suppose one desires to control a continuous time differential equation control system to track a desired output trajectory. In order to track a desire output one needs to establish the relationship between the applied control input and the output. However, this is not sufficient. In addition to the dependence between the input and the output, there may be a part of the system, the internal zero dynamics of the system, that does not enter explicitly into the relation between the input and the output. A difficult problem arises when the zero dynamics is unstable; and such systems are called Non-Minimum Phase. Constructing the control so that the output follows exactly the desired signal, will cause problems relating to the internal unstable dynamics of the system and this is not applicable in practice. Stable control of such systems is not an easy task and the present paper presents the relevant theory and some suitable tracking control methodologies.

Fri 10:20-10:40 – TID38

Development of a Chemical Plant Hybrid Automaton Model for On-line Scheduling Optimization

Simeonova, Iliyana

The aim of the research project is the development of on-line scheduling optimization methods

for hybrid chemical plants which are made of several parallel production lines that share common resources.

In this communication, we report on the first step of this study, namely the development of a dynamic model based on the hybrid automaton formalism. The considered chemical plant consists of several interacting parts: two batch reactors, several supply pumps (reactant, cold and hot water) and a storage tank. Basically, each component is represented by an hybrid automaton and the overall process is actually a combination of several automata.

The modelling procedure basically involves three main parts : determination of the discrete stages, definition of the transitions and modeling of the continuous process dynamics. Because we are dealing with a chemical process, the continuous dynamics modeling is essentially based on mass and energy balances.

A simulator of the chemical plant has been developped and implemented in Matlab environment : the Stateflow toolbox is used to describe the discrete states of the hybrid automaton and is coordinated with the Simulink toolbox which is used to describe the continuous dynamics of each stage. The obtained simulation results coincide with the theoretical expectations.

Fri 11:10-12:00 (Invited) – IS08

Oscillators as systems

Sepulchre, Rodolphe

Oscillators and rhythmic systems are ubiquitous in nature and they play an increasing role in engineering applications. But current system theory lacks tools for the modelling, analysis, and synthesis of such systems.

This talk will present our ongoing effort to develop a system theory for oscillators in which important physical phenomena such as excitability, resonance, synchronization, and phase-locking result from specific input-output and interconnection properties that can be both analyzed and engineered.

The questions that we will formulate arise from concrete research projects that strongly rely on properly orchestrating the dynamics and interconnection of "oscillators": the design of stable oscillations in underactuated mechanical systems, the design of a (bounce) juggling robot, the design of collective motions for groups of agents, and an input-output characterization of the Hodgkin-Huxley oscillator.

Fri 12:00-12:20 – TID32

Stability of elastic Systems

Caiado, M.Isabel

Stability and stabilization by introducing fast oscillations into a system are widely studied in literature. Basic example is stabilization of equilibrium of inverted pendulum by means of fast harmonic oscillation of its suspension point, [Arn89].

Methods of high-order averaging developed in [Sary01] allowed us to study stability and asymptotic stability of a wider class of time-variant systems. As an illustration a stabilization condition for pendulum under arbitrary (fast) oscillation of its suspension point has been established. An extension of this work onto the case of double inverted pendulum was done in [MicS03].

Now we intend to study a wider class of systems: the class of elastic systems described by means of a partial differential equation. The main goal is to establish conditions for the stabilization of an elastic system by imposing a fast oscillation. We suppose to extend the tools of high-order averaging and chronological calculus onto a class of infinite-dimensional systems.

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Fri 12:20-12:40 – TID33

Feedback Maps for Generalized shifted Inverse Iterations

Jordan, Jens

In applications it is often possible to project a high dimensional problem on a low dimensional invariant subspace. Therefore eigenspace computations play an important role in engineering and physical science. A classical and very successful algorithm for the case $p = 1$ and $A = A^T$ is the Inverse Iteration with Rayleigh shift. A generalization for $1 \leq p < n$, The Grassmann-RQI, can be interpreted as a shifted Inverse Iteration on the Grassmann manifold with a certain feedback control.

In my talk I want to discuss a family of different feedback strategies. This leads to a discrete-time control system on the Grassmann Manifold. The choice of the feedback laws is restricted by the structure of the Inverse Iteration. Nevertheless we show the existence of a sufficient large set of well-posed shift strategies. Furthermore we will prove local convergence for a certain cases.

Fri 14:40-15:20 (Invited) – IS02

Dynamic Systems with Symbolic Inputs

Bicchi, Antonio

In this talk I consider some aspects involved in the analysis and control of dynamic systems under symbolic command.

Symbolic commands are inputs to the dynamic systems which take values in a finite or countable set, and arise in a wide variety of systems. Their occurence may be due to the nature of the system itself, or to technological limitations (such as finite bandwith in networked embedded control systems), or may be intentionally introduced to achieve more compact and efficient abstractions of possible behaviours.

I will overview recent results related to the analysis of reachability for such systems, including a discussion of density/discreteness and lattice structures of the reachable set, and an extension of the classical notion of discrete nonholonomy. I will also point at some results and open research directions concerning synthesis of planning strategies and optimization for systems with symbolic inputs, and their stabilization.

Fri 15:20-15:40 – TID25

On dynamic dexterity and isotropy of mobile robots

Zadarnowska, Katarzyna

Keywords: Mobile robot, kinematics, dynamics, dynamic dexterity, dynamic isotropy.

The paper is aimed at expressing robotic concepts of dexterity and isotropy for mobile robots in a language of control theory. We shall consider nonholonomic mobile robots subject to Pfaffian

phase constraints, like wheeled mobile robots whose motion is subordinated to the requirement of nonslipping of the wheels. The robot kinematics and dynamics are represented by an affine control system with outputs. The system is driven by the force and torque inputs called dynamic endogenous configurations. For fixed initial conditions and the control time horizon the input-output map of the system is treated as the dynamic task map of the mobile robot. The derivative of this map, computed at a given endogenous configuration is called it dynamic task Jacobian. Dynamic endogenous configurations at which the Jacobian is surjective are called regular, the other are singular configurations of the mobile robot. The Jacobian describes the behaviour of the linear approximation of the control system representing the kinematics and the dynamics of the mobile robot, and transforms directions of motion in the dynamic endogenous configuration space into those in the taskspace. The regularity of configurations means full rank of the output controllability Gram matrix of the linear approximation, called the dynamic dexterity matrix of the mobile robot. The local behaviour of the control system representation is assessed by introducing the dynamic dexterity ellipsoid defined by means of the dynamic dexterity matrix. The volume of the dynamic dexterity ellipsoid measures dexterity of a mobile robot at a given configuration. Similarly, the ratio of the maximal and minimal eigenvalues of the dynamic dexterity matrix measures isotropy of the configuration of a mobile robot. In particular, both the dexterity and the isotropy establish how much a given dynamic endogenous configuration differs from singular. Dynamic perfomance measures are used in the paper in order to determine dynamically dextrous and isotropic configurations of an exemplary mobile robot.

Fri 15:40-16:00 – TID50

Non-symmetric choreographies in N-body problem.

Tomasz, Kapela

We prove the existence of nonsymmetric choreographies - solutions of the planar N-body problem on which all bodies travel on the same curve. Other known choreographies existence proofs need some symmetry constraints. We provide general method of computer assisted proofs using only first integrals to isolate solution. Using this method we proved, as an example, the existence of nonsymmetric choreography of 7 bodies.

Fri 16:20-16:40 – TID28

Linear-quadratic optimal control problems and spline functions in Euclidean spaces

Rodrigues, Rui C.

Scalar generalized splines were introduced in the fifties by Ahlberg, Nilson and Walsh. These curves extend polynomial splines, a class of curves that includes the well known cubic spline. Since then, spline curves have been very useful in several applied areas of mathematics such as computer graphics and approximation theory. Since the early nineties there has been an increasing interest to combine splines with control theory in order to be able to approach new problems in areas such as aircraft control and robotics path planning. The connection between scalar generalized splines and optimal control was also established and revealed that, at least in the linear case, splines are in fact a consequence of optimal control rather than a tool to be used in control theory. Based on that point of view and following similar ideas, we have been able to realize that some classical optimal control problems lead naturally to other kind of spline functions in general Euclidean spaces which we call generalized splines. Classical optimal control problems related to non-autonomous linear control systems are discussed using mainly Pontryagin's maximum principle. That approach enables spline curves to appear naturally.

Fri 16:40-17:00 – TID52

Parameter estimation in heat and mass transfer models

Rodríguez Fernández, María

Here, we consider the development of distributed parameter models for heat and mass transfer processes from the food industry and related bio-processes. After the model structure is selected, parameter estimation (model calibration) is the key step in the development of reliable dynamic models for food and bioproducts processing. Since most food processing models involve coupled nonlinear phenomena (like heat and mass transfer), usually described by sets of partial and ordinary differential equations, suitable methods must be used in order to ensure proper estimation of the parameters. In particular, it is well known that traditional (gradient-based) methods for data fitting in nonlinear dynamic systems can suffer from slow and/or local convergence, among other problems. However, this is frequently ignored, potentially leading to wrong conclusions about e.g. the validity of a model regarding a certain data set. In order to surmount these difficulties, we present alternative methods based on global optimization. Their capabilities are illustrated considering a case study involving coupled heat and mass transfer dynamic models.

Fri 17:00-17:20 – TID53

Steady state controllability of some distributed systems

Garavello, Mauro

We present some results about steady–state controllability for the heat equation and the Saint–Venant equation. Our method consists in applying the Laplace transform and studying distributions of zeroes of holomorphic functions.

Fri 17:20-17:40 – TID48

Control of a planar system with quantized and saturated input/output

Cepeda, Alfonso

In this paper the stabilization problem for a simple (unstable) planar system in the presence of input and output quantization and saturation is addressed. It is shown that global stability to a terminal set is achieved by means of a hybrid output feedback control law, which reads out the plant only three values and delivers a control action composed of three values. Simulations results complete the work.

Fri 17:40-18:00 – TID55

Controllability of the Dubins' problem for surfaces

Sigalotti, Mario

The classical Dubins' problem consists in finding the shortest curve of prescribed maximal geodesic curvature which connects two points of the plane, being tangent, at such points, to two given directions. The problem admits a natural formulation as time-optimal control problem on the unit tangent bundle of the Euclidean plane. This formulation extends to any Riemannian two-dimensional manifold M. Our aim is to study the controllability of such control system, in dependence on the geometry of M. Assume that M is complete and oriented, and denote by K its Gaussian curvature. When K is constant and non negative, it is known that the system is always completely controllable. If K is constant and negative, and M is simply connected, then the system is controllable if and only if the upper bound on the geodesic curvature of admissible curves exceeds $-K$. The talk presents some results, obtained in collaboration with Yacine Chitour, which apply

to the non-constant case. Complete controllability of the system is proved in the following three situations: (i) when M is compact; (ii) when it is unbounded and K tends to zero at infinity; (iii) when K is bounded and nonnegative outside a compact subset of M. Controllability on hyperbolic surfaces is also completely characterized.

Sat 09:10-10:00 (Invited) – IS01

Geometric control Theory for Mathematical Fluid Mechanics

Agrachev, Andrei

Joint work with A. Sarychev.

Sat 10:00-10:20 – TID35

Least Squares Problem on Riemannian Manifolds

Machado, Luís

Our objective is to solve the following least square problem on a Riemannian manifold M: Given a finite set of distinct points in M, $q_0, q_1, \ldots, q_N$ and a sequence of instants of time $0 = t_0 < t_1 < \cdots < t_N = 1$, find a curve that minimizes the functional

$$J(\gamma) = \sum_{i=0}^{N} d^2\left(q_i, \gamma(t_i)\right) + \lambda \int_0^1 \langle \frac{D^2\gamma}{dt^2}, \frac{D^2\gamma}{dt^2} \rangle \, dt,$$

over the class of twice continuously differentiable curves in M, where $d(p, q)$ stands for the geodesic distance between points p and q, $\langle \cdot, \cdot \rangle$ is the Riemannian metric on M, $\frac{D^2\gamma}{dt^2}$ denotes the covariant acceleration along γ and $\lambda > 0$ is a smoothing parameter.

We derive necessary optimality conditions for this problem and prove that when λ converges to $+\infty$ one obtains the geodesic on M that best fits the given set of points.

The classical linear regression method in Euclidean spaces arises naturally as a particular case of the above problem.

Finally, we analyze this problem for particular cases of Riemannian manifolds like Lie groups and symmetric spaces. In particular, we deduce the counterparts of the "normal equations" given by the classical least squares problem in Euclidean spaces for the Lie group of special orthogonal matrices $SO(n)$ and for the $n-$dimensional unitary sphere S^n.

Sat 10:20-10:40 – TID43

On feedback classification of four-dimensional affine control systems with one or two inputs

Zelenko, Igor

We will describe the construction of the canonical frame for four-dimensional affine systems with one input, satisfying some generic assumptions. Using this frame we obtain the local normal form for such systems. It gives the canonical "parametrization", up to state-feedback transformation, of such systems in a neighborhood of given point by two arbitrary functions of four variables and four "almost" arbitrary functions of three variables (the term "almost" means a kind of normalization of these functions on some coordinate plane and coordinate line). Then we will show how to apply our method for obtaining a "microlocal" normal form for some big class of three-dimensional control systems with one input. Further we will explain how the problem of feedback-equivalence of four-dimensional affine systems with two inputs can be reduced to the same problem for four-dimensional affine systems with one input. Finally for a given four-dimensional affine system with

two inputs we will give a construction of feedback invariants, which are obstacles for its (x, u)-dynamical linearazibility (a special kind of flatness). Namely, these invariants have to be equal to zero for (x, u)-dynamical linearazable system. The construction of these invariants is based on the use of the coordinates of the Engel normal form of rank 2 distribution, corresponding to our affine system, and on the existence of the canonical projective structure on each abnormal extremal path of this distribution. Some of the results of my talk were obtained in collaboration with A. Agrachev and J.-B. Pomet.

Sat 11:10-12:00 (Invited) – IS07

Motion planning for one-dimensional linear PDEs

Martin, Philippe

Motion planning, i.e., the construction of an open-loop control connecting an initial state to a final state, is a fundamental problem of control theory both from a practical and theoretical point of view. For finite-dimensional linear systems, controllability is equivalent to the existence of a so-called canonical Brunovsky form. All the systems variables can be then expressed as finite linear combinations of a "flat output" and its derivatives. In particular, this expression provides an explicit open-loop control for motion planning. We generalize here this picture and apply it to two examples of 1-D linear partial differential equations with boundary control: the heat equation and the linearized Korteweg-De Vries equation. The system variables can be expressed as an infinite linear combinations of a "flat output" and its derivatives. This series can be seen as a decomposition on a dense family of functions playing the role of the "Brunovsky basis". It is convergent as soon as the flat output is restricted to be of suitable Gevrey order. The family can be computed by solving a sequence of ordinary differential equations. This provides an explicit open-loop control achieving approximate motion planning.

Sat 12:00-12:20 – TID22

Drawing natural splines on a Lie group

Jakubiak, Janusz

A number of practical applications use discrete data as waypoints controlling a flow of a continuous process. The discrete data, which is either a result of measurements or a task definition , is transformed into the continuous form by one of the methods of interpolation. The interpolating continuous curve is often defined as a spline, i.e. as a set of functions of a simple form linked in a way that ensures glob al smoothness of the resulting curve. For the splines which belong to an Euclidean space there exist widely known spline types like cubic splines or B-splines and algorithms of their calculation, however they can not be easily translated into non-Euclidean spaces, what may be required in some applications.

One of such practical applications of spline generation algorithm is definition of a rigid body motion. This is a common task in animation of a moving object or planing a trajectory of an object grasped by a robotic manipulator. In such case not only the position of the element, but also its orientation should change smoothly. For this reason there exist a need of an algorithm of finding a spline on a group of rotations.

In this work we propose the algorithm which allows calculation of a spline on Lie groups. The algorithm is similar to the de Casteljau algorithm, however its complexity is reduced. The initial data of the algorithm is the set of frames, where each of the frames consists of one element of the Lie group and an element from the corresponding tangent space. The frames define waypoints of the spline, i.e. the points where the spline and its derivative are equal to the frame elements.

In this algorithm spline generation may be divided in two phases, in first the frame data are used to define geodesics called left and right spline components. In the second phase the points on the spline are calculated. The resulting spline consists of points which belong to the geodesics

connecting the left and the right components. The smoothness of the spline is ensured by a proper choice of a scalar function called the smoothing function. The splines which are generated by the algorithm are the natural splines, what means that the segments between each two consecutive frames may be calculated separately. As the result, the linking of the splines in waypoints protects the smoothness of the whole curve. To illustrate the behavior of the algorithm we present a result of an application of the algorithm to a rotation of a rigid body in 3D.

Sat 12:20-12:40 – TID39

Feedback control of a mobile robot with an on board camera

Clément, Boussard

The aim of this project is to design feedback control algorithms for automatic driving of mobile robots on the basis of the image collected by an on board camera. The task which is presently investigated is the automatic tracking with a maximal speed of a line drawn on the floor.

The first step of the study deals with image processing : from the image given by the camera, a functional parametrisation of the line is derived in the frame attached to the robot.

Then, in a second step, a control law based on differential flatness is designed and implemented.

In addition to the methodology, an experimental validation with a laboratory mobile robot will be reported and illustrated.

Sat 14:40-15:00 – TID44

Designing a heterogeneous simulator for urban traffic

Avram, Camelia

This paper describes an urban area simulator. Simulation has been defined by Shannon as the process of designing a computerized model of a system (or process) and conducting experiments with this model for the purpose either of understanding the behavior of the system or of evaluating various strategies for the operation of the system. The urban area consists of different components with different models: - short segments; - long segments; - uncontrolled crossroads; - crossroads controlled by traffic light;

The simulator integrates all these heterogeneous models by carefully describing their interface. In case of a short segment the simulator must be accurate enough to return useful information about the traffic status. In a short segment each car is observed when enter/exit on/from the segment. For a long segment only the aggregated traffic flow is modeled because tracking individual car implies big computations time and also some time we dont have enough information from the field. The crossroads connect several short segments and also have a description about the topology and the traffic priority.

The simulator was designed using java programming language. The initial state and the map of the system are read from an external file. For each car a thread is started in case of a short segment. Driving the car inside of the map is simplified by the fact that all the time the car knows only the next segment not the entire map; to change the direction of the car you need just to set up the next segment. Two long segment are connected if they are neighbor and they are using two functions (sending and receiving) for communication which represents the number of cars that want to leave the segment and the number of cars who actually enter the next segment. These two functions could be different if the upstream segment is full and there are no free places for another car to enter on the segment. All the events that occur during the simulation (such as: cars enter on the segment, car exit from the segment, changing the color of the traffic light etc.) are written in a .txt file and this file could be use to analyze the behavior of the system. A graphical user interface is also provided for an online view of the evolution of the simulator.

Sat 15:00-15:20 – TID51

Dynamic optimization in food process engineering

García García, María Sonia

Food processing plants are usually operated in batch or semi-continuous mode. Dynamic optimization techniques can be used to compute optimal operating policies which can ensure maximum profits and product quality. However, the non-linear and highly constrained nature of food processing models can make dynamic optimization a daunting task. Here, we analyse the performance of several state of the art methods considering two selected case studies. We also propose sequential re-optimization strategies in order to avoid convergence problems.

Sat 15:20-15:40 – TID23

High gain multiobservers

Wyrwas, Malgorzata

The idea of the construction of high gain observers that estimate the whole class of indistinguishable states was introduced in [Z.Bartosiewicz and M.Wyrwas, "On multiobservers for nonlinear systems", In: Progress in Simulation, Modelling, Analysis and Synthesis of Modern Electrical and Electronic Devices and Systems, World Scientific, 1999]. Such observers were called multiobservers. Thus a multiobserver is a system, whose input is the output of the original system and whose output is a multivalued map with values in $\mathbb{R}^n$. We assume that considered systems are locally observable. Then usually there are states that are indistinguishable and the output of the multiobserver for locally observable systems is a multivalued mapping (multifunction) whose values are discrete subsets of $\mathbb{R}^n$. This multifunction is well defined only on the image of the analytic map that determines the indistinguishability relation. The problem that we study is connected with the extension of such a mapping on the whole space. We assume that some sets are retracts of the whole space $\mathbb{R}^N$. Then it is possible to find a continuous extension of the multifunction over $\mathbb{R}^N$.

Sat 15:40-16:00 – TID40

Model Predictive Control of Linear Continuous Time Singular Systems Subject to Input Constraints

Yonchev, Andrey

In this presentation stabilization of linear continuous time singular systems subject to input constraints is considered. Specifically the use of a sampled - data model predictive control scheme is proposed. The objective of the presentation is to derive a control law such that the closed loop is stable (in the sense of convergence to the origin), impulse free (assuming consistent initial conditions), and satisfies the input constraints. Stability of the closed loop is achieved in a similar manner as for nonsingular systems, i.e. by utilizing a suitable penalty term and a terminal region, that is rendered invariant by local linear control law. The problem of avoidance of impulsive solutions is overcome by enforcing the input to be sufficiently smooth and by using consistent initial conditions. Approaches to obtain the terminal region, the final penalty term and the local controller are presented. For the solution of the resulting optimal control problem, which must be solved repeatedly on-line to obtain the applied input signal, two solution approaches are proposed. One is based on direct optimization approaches for optimal control problems, while in the other approach a two point boundary value problem is solved. As shown, the resulting sampled data model predictive control scheme leads to stability in the sense of convergence and to an impulse free closed loop.

Sat 16:20-16:40 – TID24

Applications of minimal Generalized Differential Quotients

Girejko, Ewa

Generalized differentials allow us to differentiate maps that are not differentiable in the classical sense. We are studying Generalized Differential Quotients (abbr. GDQs) introduced recently by H. Sussmann. GDQs, unlike usual derivatives, are not unique. Existence of minimal GDQs, in the sense of inclusion of sets, has been proved. As an application of this result we consider nonsmooth vector fields. Then the flow map is not classically differentiable with respect to the initial condition. But minimal GDQ of the flow satisfies a differential inclusion where also minimal GDQ of the vector field appears.

Sat 16:40-17:00 – TID41

Nonstandard Palais-Smale conditions

Costa Martins, Natália

Many results in Critical Point Theory involve a useful technical assumption: the Palais-Smale condition. If E is a Banach space we say that a C^1 functional $f : E \to \mathbb{R}$ satisfies **Palais-Smale condition (PS)** if every sequence $(x_n)_{n\in\mathbb{N}}$ in E such that $(f(x_n))_{n\in\mathbb{N}}$ is bounded and $\lim_{n\to\infty} f'(x_n) = 0$ has a convergent subsequence. We present and relate some nonstandard versions of (PS). Namely, if E is a separable Banach space, f satisfies (PS) if and only if

$$\{u \in {}^\star E : f(u) \in fin({}^\star\mathbb{R}) \wedge f'(u) \approx 0\} \subseteq ns({}^\star E)$$

where $fin({}^\star\mathbb{R})$ denotes the set of finite hyperreals numbers and $ns({}^\star E)$ denotes the set of near-standard elements of ${}^\star E$.

Sat 17:00-17:40 (Invited) – IS03

Nonstandard techniques for optimal control theory

Cutland, Nigel

Techniques from nonstandard analysis provide a natural way to tackle problems of optimal control theory of differential equations: if c(n) is a minimising sequence of controls for a given system then an optimal control (in some sense) is obtained by taking the nonstandard control c(N) for infinite N - which is possible within the framework of nonstandard analysis. (In this framework there are genuine nonzero infinitesimal numbers and genuine infinite natural numbers.)

We will survey the way in which these ideas can be made precise in the setting of finite dimensional differential equations including stochastic differential equations. In some cases it is necessary to interpret the non-standard optimal control as a generalised standard control for example, a relaxed control.

Recently these ideas have been extended to the Navier-Stokes equations in collaboration with K. Grzesiak. There are two new sources of difficulty here: (a) the equations are infinite dimensional (they are PDEs) and (b) there is a problem of uniqueness of solutions (it is still a major open problem). We will describe briefly the results that have been obtained for these equations both deterministic and stochastic.

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8 About the Participants

NAME: Abrunheiro, Lígia
AFFILIATION: Universidade de Aveiro, Portugal
EMAIL: ligia.abrunheiro@isca.ua.pt
MEMBERSHIP: Other Participant

NAME: Agrachev, Andrei
AFFILIATION: SISSA/ISAS, Italy
EMAIL: agrachev@sissa.it
MEMBERSHIP: Invited Speaker
TALK: "Geometric control Theory for Mathematical Fluid Mechanics" – Sat 09:10-10:00 (Invited)

NAME: Avram, Camelia
AFFILIATION: Tehnical University of Cluj Napoca, Romania
EMAIL: aclaudia1@yahoo.com
MEMBERSHIP: CTS Fellow
TALK: "Designing a heterogeneous simulator for urban traffic" – Sat 14:40-15:00

FELLOWSHIP: HPMT-GH-01-00278-71
HOME SUPERVISOR: Tiberiu COLOSI – Tiberiu.Colosi@aut.utcluj.ro
HOST SUPERVISOR: Rene BOEL – rene.boel@UGent.be,
HOST INSTITUTION: Universiteit Gent
STARTING DATE AND DURATION: 1 February 2004; 4 months

FELLOWSHIP: HPMT-GH-01-00278-xx
HOME SUPERVISOR: Tiberiu COLOSI – Tiberiu.Colosi@aut.utcluj.ro
HOST SUPERVISOR: Frank ALLGOWER – allgower@ist.uni-stuttgart.de
HOST INSTITUTION: University of Stuttgart
STARTING DATE AND DURATION: 1 September 2004; 6 months

NAME: Bastin, Georges
AFFILIATION: CESAME, Louvain University, Belgium
EMAIL: bastin@auto.ucl.ac.be
MEMBERSHIP: Other Participant

NAME: Bicchi, Antonio
AFFILIATION: Universitá di Pisa, Italy
EMAIL: bicchi@ing.unipi.it
MEMBERSHIP: Invited Speaker
TALK: "Dynamic Systems with Symbolic Inputs" – Fri 14:40-15:20 (Invited)

NAME: Borges, José
AFFILIATION: Instituto Superior Tecnico, Portugal
EMAIL: borges@dem.ist.utl.pt
MEMBERSHIP: CTS Fellow
TALK: "The use of Separable Least Squares for the identification of composite state-space models" – Th 16:20-16:40

FELLOWSHIP: HPMT-GH-01-00278-43
HOME SUPERVISOR: Miguel AYALA BOTTO – AyalaBotto@ist.utl.pt
HOST SUPERVISOR: Michel VERHAEGEN – M.H.G.Verhaegen@its.tudelft.nl
HOST INSTITUTION: Delft University of Technology
STARTING DATE AND DURATION: 1 September 2003; 12 months

NAME: Burlion, Laurent
AFFILIATION: Laboratoire des Signaux et Systèmes, France
EMAIL: burlion@lss.supelec.fr
MEMBERSHIP: CTS Fellow
TALK: "Viability approach for multi-model switching systems" – Th 10:00-10:20

FELLOWSHIP:
HOME SUPERVISOR: F. Lamnabhi-Lagarrigue – lamnabhi@lss.supelec.fr
HOST SUPERVISOR: Gianna Stefani – stefani@dma.unifi.it
HOST INSTITUTION: University of Florence
STARTING DATE AND DURATION: 15 June 2004; 3 months

NAME: Caiado, M.Isabel
AFFILIATION: University of Minho, Portugal
EMAIL: icaiado@math.uminho.pt
MEMBERSHIP: CTS Fellow
TALK: "Stability of elastic Systems" – Fri 12:00-12:20

FELLOWSHIP: HPMT-GH-01-00278-35
HOME SUPERVISOR: Andrey V. SARYCHEV – asarychev@unifi.it
HOST SUPERVISOR: PierLuigi ZEZZA – pzezza@facec.cce.unifi.it
HOST INSTITUTION: University of Florence
STARTING DATE AND DURATION: 1 March 2003; 9 months

FELLOWSHIP: HPMT-GH-01-00278-52
HOME SUPERVISOR: Andrey V. SARYCHEV – asarychev@unifi.it
HOST SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST INSTITUTION: SISSA – Trimester DCS
STARTING DATE AND DURATION: 1 September 2003; 3 months

NAME: Camarinha, Margarida
AFFILIATION: Departamento de Matemática, Universidade de Coimbra, Portugal
EMAIL: mmlsc@mat.uc.pt
MEMBERSHIP: Organizer

NAME: Cepeda, Alfonso
AFFILIATION: Dto. Ingenieria de Sistemas y Automatica. Univ. Sevilla, Spain
EMAIL: cepeda@cartuja.us.es
MEMBERSHIP: CTS Fellow
TALK: "Control of a planar system with quantized and saturated input/output" – Fri 17:20-17:40

FELLOWSHIP: HPMT-GH-01-00278-20
HOME SUPERVISOR: Eduardo CAMACHO – eduardo@cartuja.us.es
HOST SUPERVISOR: Alessandro ASTOLFI – a.astolfi@ic.ac.uk
HOST INSTITUTION: Imperial College, London

STARTING DATE AND DURATION: 1 Decembre 2002; 6 months

NAME: Chambrion, Thomas
AFFILIATION: Université de Bourgogne, France
EMAIL: thomas.chambrion@u-bourgogne.fr
MEMBERSHIP: CTS Fellow

FELLOWSHIP: HPMT-GH-01-00278-11
HOME SUPERVISOR: Jean-Paul GAUTHIER – gauthier@u-bourgogne.fr
HOST SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST INSTITUTION: SISSA, Trieste
STARTING DATE AND DURATION: 1 April 2002; 6 months

FELLOWSHIP: HPMT-GH-01-00278-47
HOME SUPERVISOR: Jean-Paul GAUTHIER – gauthier@u-bourgogne.fr
HOST SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST INSTITUTION: SISSA – Trimester DCS
STARTING DATE AND DURATION: 1 September 2003; 3 months

NAME: Cimatoribus, Carla
AFFILIATION: CTS fellowship, Germany
EMAIL: carla.cimatoribus@libero.it
MEMBERSHIP: CTS Fellow
TALK: "Using system theoretic tools for model discrimination in apoptosis" – Th 18:00-18:30 (POSTER)

FELLOWSHIP: HPMT-GH-01-00278-xx
HOME SUPERVISOR: Nicola ELVASSORE – nicola.elvassore@unipd.it
HOST SUPERVISOR: Frank ALLGOWER – allgower@ist.uni-stuttgart.de
HOST INSTITUTION: University of Stuttgart
STARTING DATE AND DURATION: 12 January 2004; 6 months

NAME: Clément, Boussard
AFFILIATION: Ecole des mines de paris, France
EMAIL: boussard@ensmp.fr
MEMBERSHIP: CTS Fellow
TALK: "Feedback control of a mobile robot with an on board camera" – Sat 12:20-12:40

FELLOWSHIP: HPMT-GH-01-00278-55
HOME SUPERVISOR: Brigitte D'ANDREA NOVEL – brigitte.dandrea-novel@ensmp.fr
HOST SUPERVISOR: Georges BASTIN – bastin@auto.ucl.ac.be
HOST INSTITUTION: Université Catholique de Louvain
STARTING DATE AND DURATION: 1 September 2003; 9 months

NAME: Clemente-Gallardo, Jesus
AFFILIATION: Universidade de Coimbra, Portugal
EMAIL: jesus@mat.uc.pt
MEMBERSHIP: Other Participant

NAME: Colonius, Fritz
AFFILIATION: University of Augsburg, Germany

EMAIL: fritz.colonius@math.uni-augsburg.de
MEMBERSHIP: Other Participant

NAME: Costa, Cristina
AFFILIATION: ESTT-Inst. Polit. de Tomar, Portugal
EMAIL: ccosta@ipt.pt
MEMBERSHIP: Other Participant

NAME: Costa Martins, Natália
AFFILIATION: Dep. Matemática - Universidade de Aveiro, Portugal
EMAIL: nataliam@mat.ua.pt
MEMBERSHIP: Other Participant
TALK: "Nonstandard Palais-Smale conditions" – Sat 16:40-17:00

NAME: Cutland, Nigel
AFFILIATION: University of Hull, England
EMAIL: n.j.cutland@hull.ac.uk
MEMBERSHIP: Invited Speaker
TALK: "Nonstandard techniques for optimal control theory" – Sat 17:00-17:40 (Invited)

NAME: Garavello, Mauro
AFFILIATION: SISSA - ISAS, Italy
EMAIL: mgarav@sissa.it
MEMBERSHIP: CTS Fellow
TALK: "Steady state controllability of some distributed systems" – Fri 17:00-17:20

FELLOWSHIP: HPMT-GH-01-00278-08
HOME SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST SUPERVISOR: Jean-Michel CORON – jean-michel.coron@math.u-psud.fr
HOST INSTITUTION: CNRS-Université Paris Sud
STARTING DATE AND DURATION: 1 May 2002; 8 months

FELLOWSHIP: HPMT-GH-01-00278-69
HOME SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST SUPERVISOR: Yacine CHITOUR – yacine.chitour@math.u-psud.fr
HOST INSTITUTION: CNRS-Université Paris Sud
STARTING DATE AND DURATION: 1 December 2003; 4 months

NAME: García García, María Sonia
AFFILIATION: IIM - CSIC, Spain
EMAIL: sgarcia@iim.csic.es
MEMBERSHIP: CTS Fellow
TALK: "Dynamic optimization in food process engineering" – Sat 15:00-15:20

FELLOWSHIP: HPMT-GH-01-00278-26
HOME SUPERVISOR: Julio R. BANGA – julio@iim.csic.es
HOST SUPERVISOR: Françoise LAMNABHI-LAGARRI – lamnabhi@lss.supelec.fr
HOST INSTITUTION: CNRS-Université Paris Sud
STARTING DATE AND DURATION: 15 January 2003; 5 months

NAME: Girejko, Ewa
AFFILIATION: Bialystok Technical University, Poland
EMAIL: egirejko@katmat.pb.bialystok.pl
MEMBERSHIP: CTS Fellow
TALK: "Applications of minimal Generalized Differential Quotients" – Sat 16:20-16:40

FELLOWSHIP: HPMT-GH-01-00278-67
HOME SUPERVISOR: Zbigniew BARTOSIEWICZ – bartos@cksr.ac.bialystok.pl
HOST SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST INSTITUTION: SISSA – Trimester DCS
STARTING DATE AND DURATION: 1 October 2003; 3 months

NAME: Guerra, Manuel
AFFILIATION: ISEG/Technical University of Lisbon, Portugal
EMAIL: mguerra@iseg.utl.pt
MEMBERSHIP: Organizer

NAME: Guffens, Vincent
AFFILIATION: UCL/CESAME, Belgium
EMAIL: guffens@auto.ucl.ac.be
MEMBERSHIP: CTS Fellow
TALK: "Using token leaky buckets for congestion feedback control in packets switched networks" – Th 17:20-17:40

FELLOWSHIP: HPMT-GH-01-00278-19
HOME SUPERVISOR: Georges BASTIN – bastin@auto.ucl.ac.be
HOST SUPERVISOR: Hugues MOUNIER – hugues.mounier@ief.u-psud.fr
HOST INSTITUTION: Ecole Superieure des Mines de Paris
STARTING DATE AND DURATION: 1 November 2002; 4 months

NAME: Haut, Bertrand
AFFILIATION: UCL - CESAME, Belgium
EMAIL: haut@auto.ucl.ac.be
MEMBERSHIP: CTS Fellow

NAME: Ioana, Tiberiu
AFFILIATION: CTS Host Institute:SISSA, Romania
EMAIL: tioana01@yahoo.com
MEMBERSHIP: CTS Fellow

FELLOWSHIP: HPMT-GH-01-00278-64
HOME SUPERVISOR: Titus PETRILA – tpetrila@cs.ubbcluj.ro
HOST SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST INSTITUTION: SISSA – Trimester DCS
STARTING DATE AND DURATION: 1 September 2003; 3 months

NAME: Jakubczyk, Bronislaw
AFFILIATION: University of Warsaw, Poland
EMAIL: B.Jakubczyk@impan.gov.pl

MEMBERSHIP: Invited Speaker
TALK: "Nonitegrable distributions and their singular curves" – Th 11:10-12:00 (Invited)

NAME: Jakubiak, Janusz
AFFILIATION: Wroclaw University of Technology, Poland
EMAIL: jjakubia@ict.pwr.wroc.pl
MEMBERSHIP: CTS Fellow
TALK: "Drawing natural splines on a Lie group" – Sat 12:00-12:20

FELLOWSHIP: HPMT-GH-01-00278-36
HOME SUPERVISOR: Ignacy DULEBA; Krzystof TCHON – iwd@ict.pwr.wroc.pl
HOST SUPERVISOR: Fátima SILVA LEITE – fleite@mat.uc.pt
HOST INSTITUTION: University of Coimbra
STARTING DATE AND DURATION: 17 March 2003; 6 months

NAME: Jordan, Jens
AFFILIATION: university of Wuerzburg/ university of Liege, Germany
EMAIL: jordan@mathematik.uni-wuerzburg.de
MEMBERSHIP: CTS Fellow
TALK: "Feedback Maps for Generalized shifted Inverse Iterations" – Fri 12:20-12:40

FELLOWSHIP: HPMT-GH-01-00278-44
HOME SUPERVISOR: Uwe HELMKE – helmke@mail.uni-wuerzburg.de
HOST SUPERVISOR: Rodolphe SEPULCHRE – r.sepulchre@ulg.ac.be
HOST INSTITUTION: University of Liege
STARTING DATE AND DURATION: 1 September 2003; 9 months

NAME: Julvez, Jorge
AFFILIATION: University of Zaragoza, Spain
EMAIL: julvez@unizar.es
MEMBERSHIP: CTS Fellow
TALK: "Modeling traffic systems with continuous Petri nets" – Th 17:40-18:00

NAME: Kawski, Matthias
AFFILIATION: Arizona State University, United States
EMAIL: kawski@asu.edu
MEMBERSHIP: Invited Speaker
TALK: "Combinatorics and Geometry in Nonlinear Control" – Th 14:40-15:20 (Invited)

NAME: Kleinsteuber, Martin
AFFILIATION: University of Würzburg, Germany
EMAIL: kleinsteuber@mathematik.uni-wuerzburg.de
MEMBERSHIP: CTS Fellow
TALK: "Computation of Time Optimal NMR Pulse Sequences for Two Spin Systems" – Th 12:00-12:20

FELLOWSHIP: HPMT-GH-01-00278-38
HOME SUPERVISOR: Uwe HELMKE – helmke@mail.uni-wuerzburg.de
HOST SUPERVISOR: Fátima SILVA LEITE – fleite@mat.uc.pt
HOST INSTITUTION: University of Coimbra
STARTING DATE AND DURATION: 1 July 2003; 3 months

NAME: Kuperman, Alon
AFFILIATION: BGU, Israel
EMAIL: alonk@ee.bgu.ac.il
MEMBERSHIP: CTS Fellow

FELLOWSHIP: HPMT-GH-01-00278-41
HOME SUPERVISOR: Paul RABINOVICI – rgadi@bgumail.bgu.ac.il
HOST SUPERVISOR: George WEISS – g.weiss@ic.ac.uk
HOST INSTITUTION: Imperial College, London
STARTING DATE AND DURATION: 15 June 2003; 5 months

NAME: Lamnabhi-Lagarrigue, Françoise
AFFILIATION: CNRS, France
EMAIL: lamnabhi@lss.supelec.fr
MEMBERSHIP: Invited Speaker
TALK: "Some new results for the control of some nonlinear hybrid systems" – Th 09:10-10:00 (Invited)

NAME: Machado, Luís
AFFILIATION: University of Coimbra, Portugal
EMAIL: lmiguel@utad.pt
MEMBERSHIP: CTS Fellow
TALK: "Least Squares Problem on Riemannian Manifolds" – Sat 10:00-10:20

FELLOWSHIP: HPMT-GH-01-00278-13
HOME SUPERVISOR: Fatima SILVA LEITE – fleite@mat.uc.pt
HOST SUPERVISOR: Bronislaw JAKUBCZYK – B.Jakubczyk@impan.gov.pl
HOST INSTITUTION: Polish Academy of Sciences, Warsaw
STARTING DATE AND DURATION: 1 August 2002; 3 months

FELLOWSHIP: HPMT-GH-01-00278-17
HOME SUPERVISOR: Fatima SILVA LEITE – fleite@mat.uc.pt
HOST SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST INSTITUTION: SISSA, Trieste
STARTING DATE AND DURATION: 1 November 2002; 5 months

NAME: Martin, Philippe
AFFILIATION: Ecole des Mines de Paris, France
EMAIL: martin@cas.ensmp.fr
MEMBERSHIP: Invited Speaker
TALK: "Motion planning for one-dimensional linear PDEs" – Sat 11:10-12:00 (Invited)

NAME: Matsikis, Iakovos
AFFILIATION: University of Exeter, England
EMAIL: I.Matsikis@ex.ac.uk
MEMBERSHIP: CTS Fellow
TALK: "Numerical Computation of Invariant Densities for Linear Stochastic Differential Equations" – Th 16:40-17:00

FELLOWSHIP: HPMT-GH-01-00278-25
HOME SUPERVISOR: Stuart TOWNLEY – townley@maths.ex.ac.uk

HOST SUPERVISOR: Fritz COLONIUS – Fritz.Colonius@math.uni-augsburg.de
HOST INSTITUTION: University of Augsburg
STARTING DATE AND DURATION: 1 April 2003; 6 months

NAME: Neves, Vítor
AFFILIATION: Dep. de Matemática/Univ. de Aveiro, Portugal
EMAIL: vneves@mat.ua.pt
MEMBERSHIP: Other Participant

NAME: Nõmm, Sven
AFFILIATION: LSS Paris/ IRCCyN Nantes, Estonia
EMAIL: sven@cc.ioc.ee
MEMBERSHIP: CTS Fellow
TALK: "Towards the characterization of identifiability of discrete-time nonlinear systems" – Th 10:20-10:40

FELLOWSHIP: HPMT-GH-01-00278-53
HOME SUPERVISOR: Ulle KOTTA – kotta@cc.ioc.ee
HOST SUPERVISOR: Claude MOOG – Claude.Moog@irccyn.ec-nantes.fr
HOST INSTITUTION: CNRS-Université Paris Sud
STARTING DATE AND DURATION: 1 October 2003; 6 months

NAME: Ofiteru, Irina Dana
AFFILIATION: University of Stuttgart, Institute for Systems Theory in Engineering, Germany
EMAIL: ofiteru@ist.uni-stuttgart.de
MEMBERSHIP: CTS Fellow
TALK: "Analyzing the Hierarchical Control of Escherichia coli Tricarboxilic Acid Cycle" – Th 18:00-18:30 (POSTER)

FELLOWSHIP: HPMT-GH-01-00278-xx
HOME SUPERVISOR: Alexandru WOINAROSCHY – a_woinaroschy@chim.upb.ro
HOST SUPERVISOR: Frank ALLGOWER – allgower@ist.uni-stuttgart.de
HOST INSTITUTION: University of Stuttgart
STARTING DATE AND DURATION: 1 March 2004; 6 months

NAME: Raluca, Roman
AFFILIATION: Faculty of Chemistry and Chemical Engineering, Cluj-Napoca, Romania
EMAIL: roman@ist.uni-stuttgart.de
MEMBERSHIP: CTS Fellow
TALK: "Modeling and Nonlinear Model Predictive Control of the product distribution of a FCCU " – Th 17:00-17:20

NAME: Ricardo, Sandra
AFFILIATION: Universidade de Trás-os-Montes e Alto Douro, Portugal
EMAIL: sricardo@utad.pt
MEMBERSHIP: Other Participant
TALK: "Newton's Algorithm in Euclidean Jordan Algebras, with Applications to Robotics" – Th 12:20-12:40

NAME: Ringkvist, Mattias
AFFILIATION: Stockholm University, Sweden
EMAIL: mattias@math.su.se
MEMBERSHIP: Other Participant

NAME: Robertz, Daniel
AFFILIATION: RWTH Aachen, Germany
EMAIL: daniel@momo.math.rwth-aachen.de
MEMBERSHIP: CTS Fellow
TALK: "Introduction to OreModules: Linear Systems over Ore Algebras" – Th 15:40-16:00

FELLOWSHIP: HPMT-GH-01-00278-29
HOME SUPERVISOR: Wilhelm PLESKEN – plesken@momo.math.rwth-aachen.de
HOST SUPERVISOR: Jean Baptiste POMET – pomet@sophia.inria.fr
HOST INSTITUTION: INRIA, Sophia-Antipolis
STARTING DATE AND DURATION: 1 February 2003; 3 months

FELLOWSHIP: HPMT-GH-01-00278-xx
HOME SUPERVISOR: Wilhelm PLESKEN – plesken@momo.math.rwth-aachen.de
HOST SUPERVISOR: Jean Baptiste POMET – pomet@sophia.inria.fr
HOST INSTITUTION: INRIA, Sophia-Antipolis
STARTING DATE AND DURATION: 1 February 2004; 3 months

NAME: Rocha, Eugénio
AFFILIATION: University of Aveiro, Portugal
EMAIL: eugenio@mat.ua.pt
MEMBERSHIP: Organizer

FELLOWSHIP: HPMT-GH-01-00278-42
HOME SUPERVISOR: Andrey V. SARYCHEV – asarychev@unifi.it
HOST SUPERVISOR: PierLuigi ZEZZA – pzezza@facec.cce.unifi.it
HOST INSTITUTION: University of Florence
STARTING DATE AND DURATION: 1 May 2003; 4 months

NAME: Rodrigues, Rui C.
AFFILIATION: University of Coimbra, Portugal
EMAIL: ruicr@isec.pt
MEMBERSHIP: Other Participant
TALK: "Linear-quadratic optimal control problems and spline functions in Euclidean spaces" – Fri 16:20-16:40

NAME: Rodrigues, Sergio
AFFILIATION: SISSA (I)/Univ Aveiro (P),
EMAIL: sesiro@hotmail.com
MEMBERSHIP: Other Participant

NAME: Rodríguez Fernández, María
AFFILIATION: Instituto de Investigaciones Marinas (IIM-CSIC), Spain
EMAIL: mrodriguez@iim.csic.es
MEMBERSHIP: CTS Fellow

TALK: "Parameter estimation in heat and mass transfer models" – Fri 16:40-17:00

FELLOWSHIP: HPMT-GH-01-00278-27
HOME SUPERVISOR: Julio R. BANGA – julio@iim.csic.es
HOST SUPERVISOR: Françoise LAMNABHI-LAGARRI – lamnabhi@lss.supelec.fr
HOST INSTITUTION: CNRS-Université Paris Sud
STARTING DATE AND DURATION: 15 January 2003; 5 months

NAME: Sepulchre, Rodolphe
AFFILIATION: Université de Liège, Belgium
EMAIL: r.sepulchre@ulg.ac.be
MEMBERSHIP: Invited Speaker
TALK: "Oscillators as systems" – Fri 11:10-12:00 (Invited)

NAME: Serres, Ulysse
AFFILIATION: SISSA/ISAS via Beirut 2-4 Trieste, Italy
EMAIL: serres@sissa.it
MEMBERSHIP: CTS Fellow
TALK: "Curvature and Feedback Classification of 2-dimensional Control Systems" – Th 15:20-15:40

FELLOWSHIP: HPMT-GH-01-00278-01
HOME SUPERVISOR: Jean-Paul GAUTHIER – gauthier@u-bourgogne.fr
HOST SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST INSTITUTION: SISSA, Trieste
STARTING DATE AND DURATION: 7 January 2002; 12 months

NAME: Sigalotti, Mario
AFFILIATION: INRIA, France
EMAIL: msigalot@sophia.inria.fr
MEMBERSHIP: CTS Fellow
TALK: "Controllability of the Dubins' problem for surfaces " – Fri 17:40-18:00

FELLOWSHIP: HPMT-GH-01-00278-07
HOME SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST SUPERVISOR: Jean-Michel CORON – jean-michel.coron@math.u-psud.fr
HOST INSTITUTION: CNRS-Université Paris Sud
STARTING DATE AND DURATION: 1 March 2002; 3 months

NAME: Silva, Cristiana
AFFILIATION: Universidade de Aveiro, Portugal
EMAIL: cjoaosilva@yahoo.com.br
MEMBERSHIP: Other Participant

NAME: Silva Leite, Fátima
AFFILIATION: Departamento de Matemática, Universidade de Coimbra, Portugal
EMAIL: fleite@mat.uc.pt
MEMBERSHIP: Organizer

NAME: Simeonova, Iliyana
AFFILIATION: Université Catholique de Louvain - Center for System Engineering and Applied

Mechanics, Bulgaria
EMAIL: simeonova@auto.ucl.ac.be
MEMBERSHIP: CTS Fellow
TALK: "Development of a Chemical Plant Hybrid Automaton Model for On-line Scheduling Optimization" – Fri 10:20-10:40

FELLOWSHIP: HPMT-GH-01-00278-33
HOME SUPERVISOR: Tzvetan SEMERDJIEV – signal@bas.bg
HOST SUPERVISOR: Georges BASTIN – bastin@auto.ucl.ac.be
HOST INSTITUTION: Université Catholique de Louvain
STARTING DATE AND DURATION: 1 February 2003; 12 months

NAME: Spindler, Karlheinz
AFFILIATION: Fachhochschule Wiesbaden, Germany
EMAIL: spindler@r5.mnd.fh-wiesbaden.de
MEMBERSHIP: Other Participant

NAME: Tomasz, Kapela
AFFILIATION: Pedagogical University, Kraków, Poland
EMAIL: tkapela@ap.krakow.pl
MEMBERSHIP: CTS Fellow
TALK: "Non-symmetric choreographies in N-body problem." – Fri 15:40-16:00

FELLOWSHIP: HPMT-GH-01-00278-58
HOME SUPERVISOR: Piotr ZGLICZYNSKI – zgliczyn@im.uj.edu.pl
HOST SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST INSTITUTION: SISSA – Trimester DCS
STARTING DATE AND DURATION: 1 September 2003; 3 months

NAME: Torres, Delfim F. M.
AFFILIATION: University of Aveiro, Portugal
EMAIL: delfim@mat.ua.pt
MEMBERSHIP: Organizer

NAME: Urzica, Daniela
AFFILIATION: University of Stuttgart, Institute for Systems Theory in Engineering, Germany
EMAIL: urzica@ist.uni-stuttgart.de
MEMBERSHIP: CTS Fellow
TALK: "Linear and Nonlinear Model Predictive Control of a high purity distillation column" – Th 18:00-18:30 (POSTER)

FELLOWSHIP: HPMT-GH-01-00278-30
HOME SUPERVISOR: Serban AGACHI – sagachi@chem.ubbcluj.ro
HOST SUPERVISOR: Frank ALLGOWER – allgower@ist.uni-stuttgart.de
HOST INSTITUTION: University of Stuttgart
STARTING DATE AND DURATION: 1 February 2003; 12 months

NAME: Van der Schaft, Arjan
AFFILIATION: University of Twente, Netherlands
EMAIL: A.J.vanderSchaft@math.utwente.nl

MEMBERSHIP: Invited Speaker
TALK: "Equivalence of dynamical systems" – Fri 09:10-10:00 (Invited)

NAME: Wronka, Cyprian
AFFILIATION: Heriot Watt University, INSA Rouen, Poland
EMAIL: cypek@cypek.com
MEMBERSHIP: CTS Fellow

FELLOWSHIP: HPMT-GH-01-00278-31
HOME SUPERVISOR: Matthew W. DUNNIGAN – m.w.dunnigan@hw.ac.uk
HOST SUPERVISOR: Witold RESPONDEK – wresp@lmi.insa-rouen.fr
HOST INSTITUTION: INSA, Rouen
STARTING DATE AND DURATION: 1 February 2003; 6 months

NAME: Wyrwas, Malgorzata
AFFILIATION: Bialystok Technical University, Poland
EMAIL: wyrwas@pb.bialystok.pl
MEMBERSHIP: CTS Fellow
TALK: "High gain multiobservers" – Sat 15:20-15:40

FELLOWSHIP: HPMT-GH-01-00278-65
HOME SUPERVISOR: Zbigniew BARTOSIEWICZ – bartos@cksr.ac.bialystok.pl
HOST SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST INSTITUTION: SISSA – Trimester DCS
STARTING DATE AND DURATION: 1 September 2003; 3 months

NAME: Yonchev, Andrey
AFFILIATION: Technical University-Sofia, Systems and Control Engineering, Bulgaria
EMAIL: ajonchev@yahoo.com
MEMBERSHIP: CTS Fellow
TALK: "Model Predictive Control of Linear Continuous Time Singular Systems Subject to Input Constraints" – Sat 15:40-16:00

FELLOWSHIP: HPMT-GH-01-00278-34
HOME SUPERVISOR: Petko PETKOV – php@mbox.digsys.bg
HOST SUPERVISOR: Frank ALLGOWER – allgower@ist.uni-stuttgart.de
HOST INSTITUTION: University of Stuttgart
STARTING DATE AND DURATION: 15 February 2003; 12 months

NAME: Zadarnowska, Katarzyna
AFFILIATION: Wroclaw University of Technology, Poland
EMAIL: kz@rab.ict.pwr.wroc.pl
MEMBERSHIP: CTS Fellow
TALK: "On dynamic dexterity and isotropy of mobile robots" – Fri 15:20-15:40

FELLOWSHIP: HPMT-GH-01-00278-62
HOME SUPERVISOR: Krzysztof TCHON – tchon@ict.pwr.wroc.pl
HOST SUPERVISOR: Andrei AGRACHEV – agrachev@sissa.it
HOST INSTITUTION: SISSA – Trimester DCS
STARTING DATE AND DURATION: 1 September 2003; 3 months

NAME: Zelenko, Igor
AFFILIATION: SISSA, Italy
EMAIL: zelenko@sissa.it
MEMBERSHIP: Other Participant
TALK: "On feedback classification of four-dimensional affine control systems with one or two inputs" – Sat 10:20-10:40

NAME: Zinober, Alan
AFFILIATION: The University of Sheffield, England
EMAIL: a.zinober@shef.ac.uk
MEMBERSHIP: CTS Fellow
TALK: "Non-Minimum Phase Control Systems (with Zhivko Stoyanov)" – Fri 10:00-10:20

9 The Best Junior Presentation Award

Junior speakers at the First CTS Workshop will contend for the Best Junior Presentation Award. As the name indicates, the prize honors the best presentation at the First CTS Workshop by a junior speaker, i. e. a CTS fellow (present or former) or a PhD student. The award is given both for presentation technique and for scientific content.

The Prize Commissioners are:

Professor Andrei Agrachev (CTS Co-Director)

Professor Alan Zinober (CTS Board Member)

Professor Fátima Silva Leite (Chair of First CTS Workshop)

The award of the prize will proceed as follows. The chair of a session, in which a junior speaker gives a presentation, and three senior volunteers in the audience will fill out an evaluation form; an example of this form is attached. After the session the completed forms will be collected by the Prize Commissioners who will compute a ranking at the end of the Workshop. The winner will be chosen by the Prize Committee from the top five presentations in this ranking, after a thorough review of the scientific content. For this, each junior speaker is requested to hand a copy of his/her slides to the Secretariat on arrival to the Workshop.

The name of the winner will be communicated during the closing ceremony of the Workshop and posted on the Workshop's website. The prize includes an award certificate.

Some detailed information concerning the prize competition is given below for the session chairs, for the volunteers in the audience who will complete the evaluation forms, and for the prize candidates.

For the session chairs

You will receive a set of envelopes corresponding to each of the junior researchers who are giving a presentation during your session, as well as a spare envelope. Each envelope contains a set of four evaluation forms. Please find three volunteers in the audience (not belonging to the research group that the speaker comes from) who are willing to complete a form. Complete one form yourself. After the talk please collect the forms, check that they are indeed completed, and put them back into the envelope. Please hand all envelopes to one of the Prize Commissioners.

For the jurors

The BJP Award depends on the efforts of those who volunteer as jurors; so your assistance is most appreciated. What we are asking you is to rate in a scale of 1 to 5 several parameters. Please

tick one box in each line; take the leftmost box if you agree with the statement on the left, the rightmost box if the statement on the right seems adequate, or choose a box in between to indicate an intermediate position. The categories appearing on the form are to be interpreted as follows.

Questions 1 to 3 deal with the scientific content of the talk: the choice of the problem (question 1), the adequacy of the theoretical tolls used to deal with the problem (question 2) and the results obtained (question 3). One can expect that scientific quality is very difficult to assess from the presentation alone. That's why we use these forms to create a short list of talks whose scientific content will be thoroughly reviewed before choosing a winner.

Question 4 asks whether the speaker clearly sets out what the talk is about and why the subject is of interest. Question 5 deals with several aspects of 'clarity'. The talk should be organized in a logical and well structured way, with the key issues clearly highlighted, the steps that lead to the realization of these goals clearly set out and subordinated to the main issues.

Question 6 deals with the way that the talk is concluded. The speaker should clearly summarize what was achieved in the work described in their research, and relate this to the goals stated at the beginning of the presentation.

Question 7 is about the speaker's use of English. Although full grammatical correctness is not an absolute requisite for effective communication, errors such as misuse of words and wrong pronunciation can be distracting and therefore should be counted negatively.

Finally, questions 8 and 9 deal with the speaker's ability to make effective use of facilities; question 8 is about the 'human' facilities (voice, facial expression, gestures, interaction with the audience), question 9 about the technical equipment (slides, overhead projector, ...).

Since the forms will be returned to the speaker, it will be helpful if you give some hints about what could be improved in the talk.

For the contestants

The ranking system associated with the prize is based on marks given by volunteers who probably do not all use the same standards, and so there is an unavoidable element of chance in the system. Therefore the prize should not be taken too seriously, and certainly should not give rise to an atmosphere of fierce competition. For the proud winner: congratulations. For all the others: the envelope with your results will be available immediately after the winner has been announced in the same room. Perusing marks and reading the suggestions that some jurors may have written on the reverse of the form, may give you some ideas of how to improve your presentation technique.

For further information regarding the BJP Award, please contact the Chair of the Workshop.

Index of Participants

Index of Talk Identifiers

Index of Participant CTS Host Institutions

Index of Countries

Evaluation Form for Presentations

Name speaker :
Session and time :

Please tick one box in each line to indicate whether you agree more with the statement on the left or with the statement on the right. For additional remarks please use the reverse side; your suggestions will be appreciated!

		1	2	3	4	5	
1.	The problem discussed is trivial or improperly formulated	☐	☐	☐	☐	☐	The problem discussed is an important scientific issue
2.	The approach to the problem is too elementary, haphazard, nonrigorous or otherwise inadequate	☐	☐	☐	☐	☐	The approach is ingenious, rigorous and perfectly suited to the problem
3.	Results are trivial, well known or clearly wrong	☐	☐	☐	☐	☐	Results are original and highly relevant
4.	Speaker just plunged into the subject	☐	☐	☐	☐	☐	Speaker took care to introduce and motivate the goals of the talk
5.	Impossible to understand connections between different issues	☐	☐	☐	☐	☐	Main points carefully brought out, intermediate steps and subgoals well stated in a clear and logical sequence
6.	Talk ended suddenly, conclusions not clear	☐	☐	☐	☐	☐	Conclusions were clearly stated and focused on the key issues
7.	Broken English, barely understandable	☐	☐	☐	☐	☐	Clear and correct English
8.	Monotone voice and behavior, avoidance or poor interaction with the audience	☐	☐	☐	☐	☐	Lively speech and performance. Speaker addressed directly the audience
9.	Slides barely readable and/or too full; speaker messed with equipment	☐	☐	☐	☐	☐	Slides were crisp and clear, speaker used all facilities smoothly

Comments and remarks to the speaker: