information brochure 2018-2019 interuniversitary graduate school

systems and control

colofon

Scientific director	Prof.dr. H. Nijmeijer
Office manager	M. (Martha) Otte
Secretariat	Secretariat DISC, Delft Center for Systems and Control, Delft University of Technology, Mekelweg 2, 2628 CD Delft, The Netherlands
Telephone	(+31)-40-2473203 (Scientific director) (+31)-15-2785572 (Office manager)
E-mail	secr@disc.tudelft.nl
Website	http://www.disc.tudelft.nl
Board	dr. J.W. Polderman (UT), chairman prof.dr. R. Babuška (TUD) prof.dr. ir. J.M.A. Scherpen (RUG) dr.ir. J.D. Stigter (WUR) prof.dr. S. Weiland (TU/e) prof.dr. H.J. Zwart (UT)

Publication date September 2018

The Dutch Institute of Systems and Control DISC has been established on January 1, 1995, by the Delft and Eindhoven Universities of Technology and the University of Twente. The administrative responsibility rests with the Faculty of Mechanical, Maritime and Materials Engineering of the Delft University of Technology.
DISC's graduate school is formally accredited by the Royal Dutch Academy of Sciences.

contents

disc – general introduction

introduction

Research school DISC is an interuniversity research institute and graduate school that unites all academic groups in the Netherlands that are active in systems and control theory and engineering. It offers a nationally organized graduate programme for PhD students in this field. Founded by the Delft and Eindhoven Universities of Technology and the University of Twente, a majority of participants in the school is affiliated with the faculties of electrical engineering, mechanical engineering, and mathematics of these three universities. A large number of other departments and institutes participate in DISC under various agreements.

goals

The ambitions of DISC are:

- To provide a PhD programme of high quality and internationally recognized level;
- To provide PhD students with a national and international network and to support them in their development towards independent researchers that are part of the international community and whose research is recognized according to international standards;
- To develop the field of systems and control through coordinated research in both fundamental and technology directed programs, and to represent this field of science in national and international networks, consortia and boards;
- To use the position of DISC as center of expertise for dissemination of knowledge on systems and control theory and engineering in the widest sense.

research program

The research program of DISC consists of fundamental and applied scientific research in the domain of systems and control theory and engineering.
By exploiting the fundamental principle of feedback, control systems enable the realization of high-tech systems in all domains of engineering science with fascinating performance in terms of speed, accuracy, autonomy and adaptability to varying circumstances.
Modelling tools are essential in analysing and designing optimal control strategies. Mathematical System Theory provides insight in the formulation of mathematical models, in the derivation of models from experimental data, and in the design of control and feedback signals.

The research program of DISC is divided in three main areas, each of which contains several themes.

1. **System and control theory**
   - System theory, nonlinear, distributed, hybrid and embedded systems;
   - Control theory for nonlinear, robust, adaptive and optimal control.
2. **Theory and application of**

system modelling
- System identification, estimation and signal processing; detection and diagnosis;
- Modelling tools: discrete events, hybrid systems, network theory, variational and geometric methods, fuzzy logic/neural networks.

3. **Applications of control engineering**
- Mechatronics, robotics, precision technology, motion control systems, biomedical, aerospace and transportation systems;
- Process control and optimization in (petro)-chemical and agricultural systems; analysis and control of biological systems.

teaching program

Through its graduate school DISC provides a program for graduate studies in systems and control offered to PhD students of the participating departments. Completing the 4-year programme of the graduate school leads to a PhD degree awarded by one of the participating universities. This programme is generally composed of a course program and a research project, leading to a PhD thesis to be defended in front of a thesis defense committee.

Educational activities of disc include:

Graduate courses on systems and control, organized in Utrecht, on a weekly basis (4 hrs/week), and lectured by national and international top lecturers.

A yearly 4-day international summer school on a particular topic or research field addressing recent developments within or relevant for systems and control.

A yearly winter course on a particular topic or research field lectured by an international lecturer.

Regular scientific DISC meetings where PhD students present their research results. The most important one is the yearly Benelux Meeting on Systems and Control, organized in cooperation with our Belgian colleagues.

msc education

Besides the PhD program in systems and control, DISC is represented in two interuniversity/national MSc programs: the national MSc program in Mathematics, and the 4TU MSc program in Systems and Control.

organization

DISC is governed by a board consisting of representatives of the three technical universities and the other universities. The daily operation of DISC is directed by the scientific director, who is assisted by the DISC secretariat.
The DISC advisory board, composed of leading representatives from industrial, university and societal bodies, meets once a year with the DISC board to discuss issues concerning strategy and policy.
The scientific director is supported by a management team consisting of all heads of DISC departments.

participation and relationships

Research groups of DISC participate in many consortia and networks with academic, institutional and industrial partners.

In conjunction with the Royal Institution of Engineers in The

Netherlands (KIVI), DISC has the status of national member organization (NMO) of IFAC, the International Federation of Automatic Control.

systems and control

Systems theory and control technology forms an academic discipline that originates from the fields of electrical and mechanical engineering and mathematics. The field has also found its way in other technical areas, in biology, medical technology, agricultural science, economics, and computer science.

systems and control field

DISC unites all academic research in the Netherlands in the field of systems and control, ranging from mathematical systems theory research to technology-driven control engineering. Mechanical manipulation of hard-disk heads, developing energy-efficient greenhouses, designing cars that drive-by-wire, autonomously walking or flying robots, operational strategies in process industry .... in all these examples systems and control theory plays a crucial role.

By exploiting the fundamental principle of feedback, control systems enable the realization of high-tech systems in all domains of engineering science with fascinating performance in terms of speed, accuracy, autonomy and adaptability to varying circumstances. Without feedback man would literally fall down.
As a field of generic tools that facilitate modelling, control, design and optimization of technological dynamical systems, the systems and control field is providing a strong enabling technology that plays a central role in very many disciplines in science and engineering.

research program

The research program of DISC consists of fundamental and applied scientific research in the domain of systems and control theory and engineering. The research domain employs modern techniques from information and computer technology to analyse, control and optimize dynamical processes, machines and (high-tech) systems. Modelling tools are essential in analysing and designing optimal control strategies, e.g. by exploiting optimization theory. Mathematical System Theory provides insight in the formulation of mathematical models, in the derivation of mathematical models from experimental data, and in the design of control and feedback signals.

The orientation towards a variety of technological application domains is important for the interplay between theoretical possibilities on the one side, and the urge to advance high-tech applications on the other side, thereby providing a fruitful stimulus for further evolution and development of the scientific area.

research themes

The three main areas in the research programme of DISC are further divided into several themes. Within each theme research lines and topics are sketched together with the acronyms of the DISC groups that participate.

1. System and control theory

System theory, nonlinear, distributed, hybrid and embedded systems

- Behavioural systems and control theory (RUG-JBI, UT-AM, TU/e-EE)
- Infinite-dimensional systems (UT-AM, WU, TU/e-EE, RUG-JBI)
- Hybrid systems (RUG-JBI, CWI, TU/e-ME, TUD-DCSC, UT-AM)
- Embedded systems (TU/e-ME, RUG-JBI)
- Nonlinear systems and control theory (RUG-ENTEG, TU/e-ME, TUD-DCSC, RUG-JBI)
- Model reduction (RUG-ENTEG, MU, TU/e-EE)

Control theory for nonlinear, robust, adaptive and optimal control

- Optimization-based control and LMI's (TUD-DCSC, TU/e-EE)
- Distributed sensing and control (TUD-DCSC, TU/e-EE, TU/e-ME)
- Adaptive control and learning (TUD-DCSC, TU/e-ME, TUD-AE)
- Nonlinear control (TU/e-ME, RUG-JBI)

2. Theory and application of system modelling

System identification, estimation and signal processing; detection and diagnosis

- System identification (TUD-DCSC, TU/e-EE, WU, CWI, MU)
- Fault detection (TUD-DCSC, TUD-AE)
- Parameter and state estimation (TUD-DCSC, WU, TUD-DIAM, TUD-AE)

Modelling tools: discrete events, hybrid systems, network theory, variational and geometric methods, fuzzy logic/neural networks

- Discrete event and hybrid systems (TU/e-ME, TUD-DCSC, TUD-DIAM, MU)
- Fuzzy systems and neural networks (TUD-DCSC)
- Physical modelling (RUG-JBI, TUD-DIAM, RUG-ENTEG)
- Financial engineering (TiU, UT-AM)

3. Applications of control engineering

Mechatronics, robotics, precision technology, motion control systems, biomedical, aerospace and transportation systems

- Mechatronics (TU/e-ME, TU/e-EE, TUD-DCSC, UT-EE, UT-ME, RUG-ENTEG)
- Aerospace systems (TUD-AE, TUD-DCSC)
- Transportation systems (TU/e-EE, TUD-DCSC)
- Smart optics systems (TUD-DCSC, TU/e-ME)
- Automotive systems (TU/e-ME, TUD-DCSC, TU/e-EE)
- Robotics (UT-EE, TUD-DCSC, TU/e-ME, UT-BE)
- Biomedical systems (TU/e-ME, UT-BE)

- Precision technology (TU/e-ME, TU/e-EE)
- Wind energy systems (TUD-DCSC)

Process control and optimization in (petro)-chemical and agricultural systems; analysis and control of biological systems

- Process control and optimization (TU/e-EE, TUD-DCSC, WU)
- Experiment design and monitoring (TUD-DCSC, WU)
- Biological systems (CWI, WU, TUD-DCSC, MU, RUG-JBI, RUG-ENTEG)
- Agricultural systems (WU, UT-AM)
- Nuclear fusion (TU/e-ME)

the graduate school of systems and control

introduction

**Through its graduate school DISC provides a program for graduate studies in systems and control offered to PhD students of the participating departments.
This graduate program runs since 1987 and is formally accredited by the Royal Dutch Academy of Sciences (KNAW), and since 2010 supported by NWO, in the scope of the NWO Graduate Programme.**

PhD students are offered a course program of weekly lectures that are given by top specialists in a central location in Utrecht. The courses cover a wide range of topics from mathematical systems theory to control engineering and intend to bring PhD students in short time to an internationally recognized research level.

Currently 148 tenured researchers, 45 post-docs and 267 PhD students in 17 DISC departments participate in DISC.

teaching program

DISC offers a graduate program in systems and control that leads to a doctorate degree of one of the participating universities. The requirements are:
Completion of a course program of 27 ECTS credits.
Completion of a doctoral dissertation, to be approved by the adviser and to be defended in front of an academic committee.

admission

Applications for PhD-membership of DISC are open to all PhD students that are supervised by an advisor who is a member of DISC. Admission to DISC requires an MSc degree in engineering, mathematics or science (to be approved by the university that grants the doctoral degree), an excellent academic record and a good motivation. PhD students are usually employed by the departments that participate in DISC and have a standard government appointment (research assistantship) for 4 years. PhD students of DISC groups should register for DISC by completing the student registration form.

International students that are interested in a graduate program in systems and control in the Netherlands have the following options:

- Apply for an advertized PhDposition in one of the DISC departments. Check the websites of the several DISC departments and the DISC site. These positions provide full financial support for the DISC graduate program.
- For students that already have a scholarship with full financial support it is advised to contact one of the DISC departments for admission to the graduate program.

Institutions that provide scholarships for graduate studies in the

Netherlands are e.g.:
nuffic http://www.nuffic.nl/.
There is no tuition fee for PhD students in the Netherlands.

For certain EU-funded research projects EU citizenship is required. International PhD students usually manage very well in The Netherlands provided that they speak the English language sufficiently well.

DISC does not have a centralized application procedure. Recruitment of PhD students is done locally by the various DISC groups. There are continuously openings for PhD positions. Potential applicants are advized to approach any research group of their interest directly to enquire about any openings.

the course program

The course program of each DISC PhD student is arranged in consultation with the student's adviser and supervisory committee and is formalized in each student's education and supervision plan. It may consist of courses offered by DISC and of suitable graduate courses provided by related graduate schools and institutes.
Yearly organized summer schools and winter courses are part of the DISC graduate program, as well as yearly participation in the Benelux Meeting on Systems and Control, that offers PhD students a platform for presentation and discussion of their results in an international setting.

At the Benelux Meeting on Systems and Control special attention is given to the presentation skills of students, through the competition for the Best Junior Presentation Award.

The course program of DISC is organized in 3 periods (trimesters). All courses are offered as independent modules, so that PhD students can start in any of the three trimesters. The course programme consists of a set of basic courses (6 ECTS) and a number of specialized short courses (3 ECTS). Usually, the basic courses are scheduled yearly, while the specialized short courses vary each year.

Examples of basic courses are:

- *Mathematical Models of Systems*
- *Design Methods for Control Systems*
- *System Identification for Control*

Examples of specialized courses that have been provided regularly in the past are

- *Linear Matrix Inequalities in Control*
- *Modeling and Control of Hybrid Systems*
- *Nonlinear Control Systems*

The course program may be completed in 12 months. It consists of three or four basic courses and a number of specialized courses.

This year’s course program with schedule and timetable can be found on page 14. The descriptions of the courses you can find on page 16 and further.

The course program of DISC is (roughly) organized in three 8-week trimesters per year In these periods courses are organized one day a week on Mondays in a central location in Utrecht. In general two courses run in parralel: one morning course (10.15h-12.30h) and one afternoon course (13.45h-16.00h).

All courses provide the students with

homework sets that have to be handed in timely for formal completion of the course and for obtaining a grade. Full credit points are only awarded to students that have attended the lectures of the course (auditing) and that have completed the homework sets with a sufficient grade. Auditing a course only (without handing in the homework sets) is rewarded with a reduced-rate ECTS: 1 credit for a 4-week course and 1,5 credit for a 8-week course. In order to receive credits all lectures should be attended. Exemption can only be made by informing the DISC secretariat in writing. All courses are taught in English.

course location

DISC courses are given in Cursus- en Vergadercentrum Domstad in Utrecht. It is located near the Utrecht-CS central railway station. For route descriptions see website www.accommodatiedomstad.nl.

fees and registration

The fee for taking or auditing a 3 ECTS DISC course is €250 and auditing or taking a 6 ECTS DISC course is € 450,-. The fee is waived for DISC students/members. Participants can register on the DISC course platform (http://disc-courseplatform.nl) or send an email to the DISC secretariat at secr@disc.tudelft.nl. Information about the DISC courses can be found on the DISC website: www.disc.tudelft.nl.

grades, credits and certificate

For each completed course participants receive a written acknowledgement of participation that includes the obtained grade and the awarded credits. A DISC-certificate is handed out when 27 ECTS are completed, of which at least 13.5 ECTS are obtained on the basis of DISC-courses. Maximally 12 ECTS may be obtained through courses of other graduate schools and maximally 6 ECTS can be obtained through other (MSc) courses that are approved by the research supervisor.

Students who wish to obtain DISC credits for non-DISC courses are advised to contact the DISC secretariat beforehand so that the course(s) can be pre-approved.

summer school

Every year DISC organizes a Summer School to familiarize students with a research topic of current interest. International specialists are invited to lecture in these summer schools. Recently organized schools are "A Systems and Control Perspective on Privacy, Safety, and Security in large-scale Cyber-Physical Systems" (2017) and "Machine Learning for Control" (2018).

winter course

Since 2009 DISC organizes a Winter Course, lectured by an international guest lecturer on a particular topic or research field relevant for systems and control. The course is typically scheduled in the winter trimester and can be organized in one or more university locations. The topic of the wintercourse 2016-2017 was "System Identification in the Life Sciences" and it was hosted by Wageningen University

benelux meeting on systems and control

The annual Benelux Meetings on Systems and Control are held alternately in The Netherlands and Belgium. They provide graduate students and researchers with a podium to present and discuss research results. The program includes keynote talks by invited international speakers and one or two mini-courses by senior researchers. Since 1996 the Best Junior Presentation Award is anually awarded for the best presentation by a PhD student. The Benelux Meeting 2019 is tentatively announced to take place from March 19-21, 2019 at Centerparcs De Vossemeren, Lommel, Belgium.

best thesis award

The DISC PhD Thesis Award is awarded anually to the PhD candidate that has defended a PhD thesis under supervision of one of the professors of DISC, and that has been selected as the best thesis by a qualified jury. The award consists of a framed certificate and a monetary present, and is announced during the Benelux Meeting. Eligible candidates have completed their thesis defense within 54 months after the start of their project, have obtained a DISC certificate of the graduate programme, and are nominated by their supervisor.

course program 2018 – 2019

term	dates	morning	afternoon
Fall 2018	3/9* 10/9 17/9	**Adaptive control** S. Baldi B. Fidan	
	1/10 8/10 15/10*	**Comptutational Linear Algebra** M. Verhaegen B. De Moor	
	12/11* 19/11*	**Underactuated Mechanical Systems** S. Porgomskiy A. Shiriaev	
Winter 2019	21/1 28/1 4/2 11/2	**Mathematical Models of Systems** J.W. Polderman H. Trentelman K. Camlibel	**Input Design and Parameter Estimation for Non-linear Systems** H. Stigter K. Keesman
	18/2 25/2 4/3 11/3		**Nonlinear Control Systems** B. Jayawardhana B. Besselink
Spring 2019	1/4 8/4 15/4 29/4	**Linear Matrix Inequalities in Control** S. Weiland	
	6/5 13/5 20/5 27/5	**Design Methods for Control Systems** T. Oomen J. van Wingerden	**Energy-based Modeling and Control** A. van der Schaft S. Stramigioli

Time table			Location
Morning	10.15 - 11.15 11.30 - 12.30	***lecture scheduled in the morning and afternoon**	Cursus- en Vergadercentrum Domstad Koningsbergerstraat 9 3531 AJ Utrecht www.accommodatiedomstad.nl
Afternoon	13.45 - 14.45 15.00 - 16.00		

course descriptions
2018 - 2019

adaptive control

lecturers

Dr. Simone Baldi, Delft University of Technology
Dr. B. Fidan, University of Waterloo

objectives

Adaptive control covers a set of techniques which provide a systematic approach for automatic adjustment of the controllers in real time, in order to achieve or to maintain a desired level of performance of the control system when the parameters of the plant dynamic model are unknown and/or change in time.

While the design of a conventional feedback control system is oriented firstly toward the elimination of the effect of disturbances upon the controlled variables, the design of adaptive control systems is oriented firstly toward the elimination of the effect of parameter disturbances upon the performance of the control system. An adaptive control system can be interpreted as a hierarchical system composed of a conventional feedback control and an adaptation loop.

The course presents a basic ground for analysis and design of adaptive control systems: it covers both established adaptive schemes based on continuous adaptation, and more recent logic-based adaptive schemes with discontinuous adaptation. The course is organized as follows: after an initiation to parameter adaptation algorithms, Model Reference Adaptive Control (MRAC) schemes constitute the core of the adaptive schemes. MRAC is addressed both from a continuous adaptation point of view and in discontinuous environments, with emphasis on networked environments (switched dynamics and quantization phenomena). The final part of the course is constituted by Adaptive Switching Control (ASC) schemes, which have emerged as an alternative to conventional continuous adaptation. ASC schemes embody a supervisory logic that performs adaptation tasks based on plant input/output data. Different families of logic-based adaptive control schemes will be introduced, including multiple-model ASC schemes, which offer, among other properties, the possibility to combine features from robust and conventional adaptive control.

At the end of the course the student should be able to:
-Design, simulate, and implement parameter adaptation schemes;
-Design, simulate, and implement adaptive control schemes;
-Master the main analytical details in stability and convergence proofs of adaptive control schemes;
-Compare different adaptive control methodologies;
-Discuss simulation results.

contents

Lecture 1 - Introduction and parameter adaptation

- Introduction to adaptive control
- Linear parametric models
- Gradient and least square algorithms

• Robust parameter adaptation laws (elements)

Lecture 2 - Model Reference Adaptive Control (MRAC)
• Model Reference Control with known parameters
• Direct/Indirect MRAC schemes
• Instability examples
• Robust MRAC schemes (elements)

Lecture 3 - Adaptive networked control
• Introduction to hybrid and switched systems (elements)
• Adaptive control of switched systems
• Adaptive quantized control

Lecture 4 - Adaptive Switching Control (ASC)
• Introduction to ASC
• Logic-based supervisors
• Multi-Model ASC

course material

1. Landau I. D., Lozano R., M'Saad M., and Karimi A., Adaptive Control: Algorithms, Analysis and Applications, 2nd edition, Springer-Verlag, 2011.
2. Ioannou P. A. and Fidan B., Adaptive Control Tutorial, SIAM, 2006.

Additional material distributed during the course.

prerequisites

Notions of linear systems theory and Lyapunov stability at the intermediate level. Notions of hybrid systems might turn out useful as well. Extra course material on these topics will be provided to take into account different entry levels. Intermediate MATLAB programming skills are also required.

homework assignments

Two homework assignments, each one accounting for 50% of the final grade. The homework assignments, distributed at the end of the second and the fourth lecture, will consist of both mathematical and programming problem solving exercises.
.

computational linear algebra: a least squares perspective

lecturers

Prof. dr. ir. M. Verhaegen, Delft University of Technology
Prof. dr. B. De Moor, KU Leuven

objectives

The computational aspects in solving fi identification and control problems is becoming more important with the event of embedded, cheap and general purpose control systems. Inspired by the evolution in hardware we observe an increase in the size of system theoretical problems that are analyzed in industry.
The numerical aspects of efficiency and accuracy in the designing numerical solutions is the driving force to computational linear algebra. The objective of this course is to show the use of linear algebra, its geometric interpretation and convex optimization in deriving new, simpler and easier to understand solutions to various system theoretical problems. In this course a number of key problems in system the- ory are formulated, solved and analyzed from a computational algebra perspective

contents

(a) Subspace identification (SI) of LTI systems
Basic linear algebra tools such as the QR factorization, the SVD and linear least squares problems allow to approximate structural information about LTI systems, such as the observability matrix, from input-output measurements. The latter data is assumed to be taken from an LTI system operating in open- loop. Different perturbation scenarios of the data are considered.
(b) Nuclear Norm convex optimization for identifying LTI systems
Subspace identification methods are characterized o.a. by the calculation of low rank approximation in order to retrive key subpsaces of interest. Generally the SVD is used for that purpose. New families of subspace identification methods have emerged that replace the SVD step by nuclear norm optimization. A brief introduction will be given to this new developement.
(c) Realization theory and distance measures between linear systems.
It turns out that there are important and surprising connections between system theory (stochastic realization, subspace principle angles, cepstral norm and distances), information theory (Shannon entropy and mutual information), statistics (canonical correlations) and signal processing (Kalman fi). We will elaborate in detail on these connections, develop the relation with sub- space identification algorithms and show how these insights can be used in datamining, more specifically in the clustering of time series.
(d) Applications of realization theory, subspace identification and distance measures.
It is little known that there are numerous applications of realization theory and subspace identification. We will elaborate on fi the roots of systems of multivariable polynomials in numerical algebraic geometry, fi eigen- frequencies and modes in modal analysis in mechanical

engineering, subspace modelling from power spectra, the so-called shape from moments problem in computer tomography and the modelling of textures in one and more dimensions. Several industrial examples of subspace identification will be discussed.

course material

Copies of all slides, and material contained in

- Book: M. Verhaegen and V. Verdult, “Filtering and System Identification: A least squares Approach”, Cambridge University Press 2007.
- Book: Van Overschee P., De Moor B., Subspace Identification for Linear Systems: Theory, Implementation, Applications, Kluwer Academic Publishers, 1996, 254 p., Downloadable from http://homes.esat.kuleuven.be/sistawww/cgi- bin/pub.pl
- PhD Thesis: De Cock K., Principal Angles in System Theory, Information The- ory and Signal Processing, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), May 2002, 337 p.

Downloadable from http://homes.esat.kuleuven.be/sistawww/cgi-bin/pub.pl..

prerequisites

A master’s degree in engineering with specialisation in signal, systems and/or control.

homework assignments

The grading is based on 2 take-home exams that will be distributed to the students during the course.

underactuated mechanical systems: motion planning, motion representation

lecturers

Prof. A.S. Shiriaev, NTNU, Norway.
Dr. A.Y. Pogromskiy, Eindhoven University of Technology.

objectives

The course helps students systematically explore several topics and research directions of modern robotics and nonlinear control theory linked to efforts in developing scalable methods for performing and analyzing agile movements of dynamically constrained robotic systems. Demands for automating various labor-intensive tasks such as grasping, manipulating or handling of external objects (performed nowadays in industry and service applications primarily by humans) motivate for model-based motion planning and control methods for such systems. Similarly, dynamic and actuation constraints are dominating in developing aggressive maneuvers for flying machines; they are important for searching and controlling gaits of walking robots etc.

Most of dynamic constraints in applications are case specific or linked to scenarios of work of mechanisms. Meanwhile, some constraints are generic and can be simultaneously present in describing behaviors of quite distant nonlinear systems. Constraints due to underactuation provide examples of such generic structural features of nonlinear mechanical systems. They appear due to system designs and literally mean an excess of a number of degrees of freedom of the system (that are representative for a searched movement) over a number of actuators available in the system (for performing the movement). For a nonlinear mechanical system, the Newton second law describing the dynamics of non-actuated variables can be interpreted as a dynamic constraint defining a continuum set of equalities, which a movement of the system must obey and which are parameterized by a time interval the motion is defined. Such non-integrable relations can be irrelevant for some tasks. For instance, underactuation constraints in local regulating a position of a drone might have a negligible effect. In similar fashion, the constraint can be ignored in process of planning and controlling of some of slow motions of a flying machine. Meanwhile, the constraints are dominant and should be taken into account in planning and performing its agile maneuvers.

The lectures provide introductory materials and problem settings to the subject exploiting generic arguments for modelling, representing and analyzing behaviors of nonlinear systems, which can be further extended and applied for controlled mechanical systems. The development is well illustrated by solving a number of comprehensive examples of increased complexity, where important mathematical concepts and tools are emphasized and exemplified. The common thread of the lectures is put on discussion of formalization of motion planning, stabilization and stability analysis assignments and on discussion of integrated approaches for solving the tasks, which are relevant to engineering applications and practice. To the end, one of lectures is devoted to the analysis and control system design for the robotic system developed for performing non-prehensile manipulation tasks.

contents

(Lecture 1: Concepts of stability of a motion. Analytical and computational tools for detecting and for analysis of cycles of nonlinear dynamic systems (Lyapunov lemma, Poincare first return map, small parameter and Krylov-Bogolyubov methods for approximate integration, Andronov theorem). Examples.

Lecture 2: Nonlinear mechanical systems with constraints. Classification of constraints. Stability of nonlinear mechanical systems with constraints. Problem formulations and settings for motion (trajectory) planning for constrained controlled mechanical systems. Concepts of a motion generator (MG) and its dynamics for mechanical systems. A nested representation of motion candidates for underactuated mechanical systems. Properties of the dynamics of a MG derived based on the nested representation of a behavior of an underactuated mechanical system. Examples of choices of MG and steps in planning feasible behaviors

Lecture 3: Concepts of transverse dynamics and moving Poincare sections for a motion of mechanical system. Analytic choices of transverse coordinates and their linearization for a motion of mechanical system. Tools for controlling a motion of mechanical system based on transverse linearization. Hybrid transverse linearization for analysis of stability and for stabilization of movements of hybrid mechanical systems (walking and running machines). Examples.

Lecture 4: The case study: non-prehensile manipulation of a passive disc rolling on a curved hand of the Butterfly robot. Choices for coordinates appropriate for representing unilateral and non-slipping constraints. Dynamics of the Butterfly robot in alternative sets of excessive coordinates. Steps in planning perpetual rotations of a passive disc on the hand of the Butterfly robot. Choices for a motion generator and for parametric sets of synchronization functions in searching feasible rotations. Transverse dynamics and transverse coordinates in a vicinity of the nominal rolling of a passive disc on the hand of the Butterfly robot. Transverse linearization and its robust stabilization. Experimental verification. Adaptivity and learning in performing non-prehensile manipulations..

course material

The lecture notes and slides will be distributed during the course.

prerequisites

Basic background in mechanics, systems and control theory. Basic programming skills in Matlab.

homework assignments

Two homework assignments will be handed out at the end of the second and forth lectures. Each assignment will contribute up to 50% of the final grade for this course..

mathematical models of systems

lecturers

Dr. J.W. Polderman, University of Twente
Prof. dr. H. Trentelman, University of Groningen
Prof. dr. K. Camlibel, University of Groningen

objective

The purpose of this course is to discuss the ideas and principles behind modelling using the behavioral approach, and to apply these ideas to control system design. In the behavioral approach, dynamical models are specified in a different way than is customary in transfer function or state space models. The main difference is that it does not start with an input/output representation. Instead, models are simply viewed as relations among certain variables. The collection of all time trajectories which the dynamical model allows is called the behavior of the system. Specification of the behavior is the outcome of a modelling process. Models obtained from first principles are usually set-up by tearing and zooming. Thus the model will consist of the laws of the subsystems on the one hand, and the interconnection laws on the other. In such a situation it is natural to distinguish between two types of variables: the manifest variables which are the variables which the model aims at, and the latent variables which are auxiliary variables introduced in the modelling process. Behavioral models easily accommodate static relations in addition to the dynamic ones. A number of system representation questions occur in this framework, among others:

- the elimination of latent variables
- input/output structures
- state space representations

We will also introduce some important system properties as controllability and observability in this setting.
In the first part of the course, we will review the main representations, their interrelations, and their basic properties. In the context of control, we will view interconnection as the basic principle of design. In the to-be-controlled plant there are certain control terminals and the controller imposes additional laws on these terminal variables. Thus the controlled system has to obey the laws of both the plant and the controller. Control design procedures thus consist of algorithms that associate with a specification of the plant (for example, a kernel, an image, or a hybrid representation involving latent variables) a specification of the controller, thus passing directly from the plant model to the controller. We will extensively discuss the notion of implementability as a concept to characterize the limits of performance of a plant to be controlled. We will discuss how the problems of pole-placement and stabilization look like in this setting.

contents

1. General ideas. Mathematical models of systems. Dynamical systems. Examples from physics and economics. Linear time-invariant systems. Differential equations. Polynomial matrices.

2. Minimal and full row rank representation. Autonomous systems. Inputs and outputs. Equivalence of representations.
3. Differential systems with latent variables. State space models. I/S/O models.
4. Controllability. Controllable part. Observability.
5. Elimination of latent variables. Elimination of state variables.
6. From I/O to I/S/O models. Image representations.
7. Interconnection. Control in a behavioral setting. Implementability
8. Stability. Stabilization and pole placement.

course materials

The main reference is Introduction to Mathematical Systems Theory: A Behavioral Approach by J.W. Polderman and J.C. Willems (Springer 1998 as e-book).

prerequisites

The course is pretty much self-contained. Basic linear algebra and calculus should suffice.

input design and parameter estimation for non-linear systems

lecturers

Prof. dr. K. Keesman, Wageningen University
Dr. H. Stigter, Wageningen University

objective

Optimal input design is a classical problem in the identification literature. One way to tackle this problem is through optimal parametric sensitivity control, using Pontryagin's minimum principle. Unlike the traditional open-loop input design methods, in this course the emphasis is on finding a control law that maximizes parameter sensitivities for a specific set of parameters in a general single input-single state-single output nonlinear state-space model that is affine in the input.

After designing an optimal input and feeding this to the system subsequently experimental data can be collected and parameters can be estimated, given the input and output data and a prior model structure. Alternatively, a combination of recursive parameter estimation and optimal input design is also demonstrated as an elegant strategy for successful identification of a nonlinear system model.

The objective of the course is to present a methodology for (i) the design of optimal input signals for minimum-variance estimation of model parameters in the class of low-dimensional, nonlinear, state-space models under indirect state measurements, (ii) the estimation of parameters in a dynamic, non-linear model, and (iii) the introduction of the necessary concepts to apply an adaptive optimal input design strategy to nonlinear state space models.

At the end of the course the student should be able to:
-Understand the concepts of parameter sensitivity and optimal parametric sensitivity control;
-Compute parameter sensitivity trajectories together with model output trajectories;
-Design optimal input signals for low-order non-linear systems, simulate the corresponding response and estimate the unknown parameter(s);
-Evaluate the input design and parameter estimation results;
-Use off- and online methods for parameter estimation and model structure identification.
contents.

contents

Lecture 1 - Introduction and background
•Introduction to course
•Parameter sensitivity and the Fisher Information Matrix
•Linear regression and Least squares estimation

Static gain observers

Lecture 2 – Optimal parametric sensitivity control
•Pontryagin's minimum principle
•Singular optimal control (SOC)
•SOC for optimal input design (OID)
•Examples

Lecture 3 - Adaptive optimal parametric sensitivity control
•Framework
•Recursive parameter estimation
•Model Predictive Control
•Adaptive OID

Lecture 4 – Identification of non-linear systems
•Introduction to non-linear parameter estimation
•Role of parameter estimation in system identification
•Real-world example

course materials

1.Keesman, KJ, System Identification: an Introduction. Springer Verlag, UK, 2011
2.Keesman KJ and Walter E, Optimal input design for model discrimination using Pontryagin's maximum principle: Application to kinetic model structures. Automatica 50(5) : 535 – 1538, 2014
3.Stigter JD and Keesman KJ, Optimal parametric sensitivity control of a fed-batch reactor Automatica 40 (8) : 1459 – 1464, 2004.
4.Stigter JD, Vries D and Keesman KJ, On adaptive optimal input design: A bioreactor case study. AIChE Journal 52 (9) : 3290 – 3296, 2006.

Additional material distributed during the course.

prerequisites

The course is pretty much self-Notions of optimal control theory and system identification at the intermediate level. Notions of Pontryagin's minimum principle and statistical estimation uncertainty might turn out useful as well. Extra course material on these topics will be provided to take into account different entry levels. Intermediate MATLAB programming skills are also required.

homework assignments

Two homework assignments, each one accounting for 50% of the final grade. The homework assignments, distributed at the end of the second and the fourth lecture, will consist of both mathematical and programming problem solving exercises.

nonlinear control systems

lecturers

Prof. dr. B. Jayawardhana, University of Groningen
Dr. B. Besselink, University of Groningen

objective

The course aims at introducing basic properties of nonlinear systems, fundamental stability notions in nonlinear systems and a set of self-contained results on the control design of nonlinear systems.

contents

Lecture 1 (Introduction to nonlinear systems). During this lecture, the students will be given examples on nonlinear systems, and several fundamental properties and stability notions of nonlinear systems will be introduced.
References
H. Khalil, *Nonlinear Systems*, 3rd edition, Prentice Hall, 2002, Chapter 1, 2, and 3.

Lecture 2 (Lyapunov stability). The students will learn Lyapunov converse theorem and characterization of input-to-state stability notion.
References
H. Khalil, *Nonlinear Systems*, 3rd edition, Prentice Hall, 2002, Section 4.7 – 4.9.
E.D. Sontag, "Input to state stability: basic concepts and results," P. Nistri & G. Stefani (eds.), Nonlinear and Optimal Control Theory, pp. 163-220, Springer-Verlag, Berlin, 2006.

Lecture 3 (Feedback linearization). In this lecture, the students will be introduced to the concept of relative-degree and normal forms. The application of these notions to feedback linearization and for control design will be given.
References
H. Khalil, *Nonlinear Systems*, 3rd edition, Prentice Hall, 2002, Chapter 13.

Lecture 4 (Nonlinear control design). During this lecture, the students will learn the backstepping control design approach.
References
H. Khalil, *Nonlinear Systems*, 3rd edition, Prentice Hall, 2002, Section 14.3.

course materials

The lecture notes will be distributed during the course.

prerequisites

The students are expected to be familiar with ordinary differential equations, linear control systems and linear algebra.

homework assignments

A set of homework assignments will be distributed at the end of each lecture.

linear matrix inequalities in control

lecturers

Prof.dr. S. Weiland, Eindhoven University of Technology

objective

Linear matrix inequalities (LMI's) have proven to be a powerful tool to approach control problems that appear hard if not impossible to solve in an analytic fashion. Although the history of LMI's goes back to the forties with a major emphasis of their role in control in the sixties (Kalman, Yakubovich, Popov, Willems), the present numerical interior point and semi-definite programming techniques are increasingly powerful to solve LMI's in a practically efficient manner (Nesterov, Nemirovskii 1994). Several Matlab software packages are available that allow a simple coding of general LMI problems that arise in typical control problems.
Because of the availability of fast and efficient solvers for semi-definite programs, the research in robust control has experienced a paradigm shift towards reformulating control problems in terms of feasibility tests of systems of LMI's where properties of convexity and semi definite programs are fully exploited to solve relevant problems in systems and control.

The main emphasis of the course is:

- to reveal the basic principles of formulating desired properties of a control system in the form of LMI's
- to demonstrate the techniques how to reduce the corresponding controller synthesis problem to an LMI problem.
- to get familiar with the use of software packages for performance analysis and controller synthesis using LMI tools.

The power of this approach is illustrated by several fundamental robustness and performance problems in analysis and design of linear control systems.

contents

1. Some facts from convex analysis. Linear Matrix Inequalities: Introduction. History. Algorithms for their solution.
2. The role of Lyapunov functions to ensure invariance, stability, performance, robust performance. Considered criteria: Dissipativity, integral quadratic constraints, H2-norm, H8-norm, upper bound of peak-to-peak norm. LMI stability regions.
3. Frequency domain techniques for the robustness analysis of a control system. Integral Quadratic Constraints. Multipliers. Relations to classical tests and to μ-theory.
4. A general technique to proceed from LMI analysis to LMI synthesis. State-feedback and outputfeedback synthesis algorithms for robust stability, nominal performance and robust performance using general scaling.
5. A choice of extensions to mixed control problems and to linear parametrically-varying controller design, robust estimation problems or the use of multiplier techniques in control system design.

course material

The main reference material for the course will be an extensive set of lecture notes by Carsten Scherer and Siep Weiland. Additional reference material:

1. S. Boyd, L. El Ghaoui, E. Feron and V. Balakrishnan, Linear Matrix Inequalities in System and Control Theory, SIAM studies in Applied Mathematics, Philadelphia, 1994.
2. L. El Ghaoui and S.I.Niculescu (Editors), Advances in Linear Matrix Inequality Methods in Control, SIAM, Philadelphia, 2000.
3. A. Ben-Tal, A. Nemirovski, Lectures on Modern Convex Optimization: Analysis, Algorithms, and Engineering Applications, SIAM-MPS Series in Optimizaton, SIAM, Philadelphia, 2001.
4. G. Balas, R. Chiang, et al. (2006). Robust Control Toobox (Version 3.1), The MathWorks Inc.
5. J. Löfberg, YALMIP, http://control.ee.ethz.ch/˜joloef/yalmip.php.

prerequisites

Linear algebra, calculus, basic system theory, MATLAB.

homework assignments

We plan to issue 4 homework sets that include choices of theoretical and practical assignments. Full credit is received for successfully solving the assigned take-home sets.

design methods for control systems

lecturers

Dr. ir. T. A. E. Oomen, Eindhoven University of Technology
Prof. dr. ir. J.W. van Wingerden, Delft University of Technology

objective

The course presents "classical," "modern" and "postmodern" notions about linear control system design. First the basic principles, potentials, advantages, pitfalls and limitations of feedback control are presented. An effort is made to explain the fundamental design aspects of stability, performance and robustness. Next, various well-known classical single-loop control system design methods are reviewed and their strengths and weaknesses are analyzed. The course includes a survey of design aspects that are characteristic for multivariable systems, such as interaction, decoupling and input-output pairing. Further LQ, LQG and some of their extensions are reviewed. After a presentation of uncertainty, model design methods based on H-infinity-optimization and mu-synthesis are presented..

contents

1. INTRODUCTION TO FEEDBACK THEORY.
   Basic feedback theory, closed-loop stability,
   stability robustness, loop shaping, limits of performance.
2. CLASSICAL CONTROL SYSTEM DESIGN.
   Design goals and classical performance criteria, integral control,
   frequency response analysis, compensator design, classical methods
   for compensator design.
3. MULTIVARIABLE CONTROL.
   Multivariable poles and zeros, interaction, interaction measures,
   decoupling, input-output pairing.
4. LQ, LQG AND CONTROL SYSTEM DESIGN.
   LQ basic theory, LQG basic theory.
5. UNCERTAINTY MODELS AND ROBUSTNESS.
   Parametric robustness analysis, the small-gain theorem, stability robustness of feedback systems, numerator-denominator, structured singular value robustness analysis, combined
   performance and stability robustness.
6. H-INFINITY OPTIMIZATION AND MU-SYNTHESIS.
   The mixed sensitivity problem, loop shaping, the standard H-infinity
   control problem, state space solution, optimal and suboptimal solutions,
   integral control and HF roll-off, mu-synthesis, application.

A. Appendix on Matrices
B. Appendix on norms of signals and systems..

course material

A full set of lecture notes will be made available on the DISC course platform..

prerequisites

Basic undergraduate courses in systems and control. Some familiarity with MATLAB is helpful for doing the homework exercises.. homework assignments. Homework sets will be distributed via the course website. Homework is graded on a scale from 1 to 10. Missing sets receive the grade 1. The final grade for the course is a weighted average of the grades for the homework sets

energy-based modeling and control

lecturers

Prof. dr. ir. S. Stramigioli, University of Twente
Prof. dr. Arjan van der Schaft, University of Groningen

contents

This course is devoted to an introduction to the theory of geometric modeling of physical systems for control. Physical systems, from mechanical, electrical, to chemical and thermal domains, share common structures, with energy and power flow their 'lingua franca'.
In this 4-week course we will introduce the basic concepts of port-based modeling of interconnected multi-physics systems. This leads to the geometric theory of port-Hamiltonian systems, which has been developed for general system classes including nonlinear, differential-algebraic, switching, and distributed-parameter systems.
Apart from providing insightful models for analysis and simulation, this framework will be of direct relevance for robust and physically motivated control design strategies. In particular, we will discuss the applications of passivity, e.g. for set-point regulation, and power-flow modulation and energy-storage strategies, e.g. for tracking. Examples will be given from different application areas, in particular robotics and electrical power networks.

course materials

The course will be based on selected chapters of the following two monographs in lecture note style (pdf’s will be made available to the students):

- G. Folkertsma, S. Stramigioli, Energy in robotics, NOW Publishers 2017.
- A.J. van der Schaft, D. Jeltsema, Port-Hamiltonian systems theory: an introductory survey, NOW Publishers 2014.

homework assignments

Grading by two take-home exams.

unit disc

Unit DISC is the council of research students of DISC. It represents the group of PhD students and interacts with the scientific director and board of DISC on all matters that relate to DISC activities and the position of PhD students. They also take care of the course evaluations. Unit DISC can be contacted through one of their representatives:

Francesco Acciani (UT-EE),
f.acciani@utwente.nl
053-4893457
Henk van Waarde(RUG-ENTEG),
H.J.van.Waarde@rug.nl
050-3638493

addresses disc departments

delft university of technology

Faculty of Mechanical, Maritime and Materials Engineering
Delft Center for Systems and Control (**TUD-DCSC**)
Mekelweg 2
2628 CD Delft

Faculty of Mechanical, Maritime and Materials Engineering
Cognitive Robotics (**TUD-COR**)
Mekelweg 2
2628 CD Delft

Faculty of Electrical Engineering, Mathematics and Computer Science
Department of Applied Mathematics
Section Mathematical Physics (**TUD-DIAM**)
P.O. Box 5031
2600 GA Delft

Faculty of Aerospace Engineering
Department of Aerospace Design, Integration & Operations
Section Control and Simulation (**TUD-AE**)
P.O. Box 5058
2600 GB Delft

eindhoven university of technology

Department of Mechanical Engineering (**TUe-ME**)
Section Dynamics and Control
Section Control Systems Technology
P.O. Box 513
5600 MB Eindhoven

Department of Electrical Engineering
Section Control Systems (**TUe-EE**)
P.O. Box 513
5600 MB Eindhoven

university of twente

Faculty of Electrical Engineering, Mathematics and Computer Science
Department of Robotics and Mechatronics (**UT-RAM**)

P.O. Box 217
7500 AE Enschede

Faculty of Electrical Engineering, Mathematics and Computer Science
Department of Applied Mathematics
Hybrid Systems Group (**UT-AM**)
P.O. Box 217
7500 AE Enschede

Faculty of Engineering Technology
Department of Mechanics of Solids, Surfaces & Systems
Structural Dynamics, Acoustics and Control (**UT-MS3**)
P.O. Box 217
7500 AE Enschede

Faculty of Engineering Technology
Department of Biomechanical Engineering (**UT-BE**)
P.O. Box 217
7500 AE Enschede

vu university amsterdam

Faculty of Sciences
Department of Mathematics
Section Mathematical Analysis (**VU**)
De Boelelaan 1081a,
1081 HV Amsterdam

university of groningen

Faculty of Science and Engineering
Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence (**RUG-BI**)
Group Systems, Control and Applied Analysis
Group Artifical Intelligence
P.O. Box 800
9700 AV Groningen

Faculty of Science and Engineering
Engineering and Technology Institute Groningen (**RUG-ENTEG**)
Division Discrete Technology and Production Automation
Division Smart Manufacturing Systems
Nijenborgh 4
9747 Groningen

maastricht university

Faculty of Science and Engineering
Department of Data Science and Knowledhe Engineering (**MU**)
P.O. Box 616
6200 MD Maastricht

tilburg university

Tilburg School of Economics and Management (TiSEM)
CentER – Center for Economic Research
Department of Econometrics and Operations Research (**TiU**)
P.O. Box 90153
5000 LE Tilburg

wageningen university and research

Department of Agrotechnology and Food Sciences
Biobased Chemistry and Technology (**WU-BCT**)
P.O. Box 17
6700 AA Wageningen

Department of Plant Sciences
Farm Technology **(WU-FT)**
P.O. Box 16
6700 AA Wageningen

scientific staff, researchers, phd students

name	e-mail address
CentER	
Secretariat: Heidi Ket (phone 013-4662462)	
e-mail: secretariaat.econometrie@uvt.nl	
Member DISC management team: dr. J.C. Engwerda	
Staff	
Dr. J.C. Engwerda	j.c.engwerda@uvt.nl
Em.prof.dr. J.M. Schumacher,	j.m.schumacher@uvt.nl
RUG – Engineering and Technology Institute Groningen	
Secretariat: Frederika Fokkens (phone 050-3638493)	
e-mail: secdtpa@rug.nl / secsms@rug.nl	
Member DISC management team: division DTPA prof.dr.ir. J.M.A. Scherpen, division SMS prof.dr. C. De Persis	
Staff	
Prof. dr. M. Cao	m.cao@rug.nl
Prof.dr. C. De Persis	c.de.persis@rug.nl
Prof.dr. B. Jayawardhana	b.jayawardhana@rug.nl
Dr. N. Monshizadeh	n.monshizadeh@rug.nl
Prof.dr.ir. J.M.A. Scherpen	j.m.a.scherpen@rug.nl
Dr. P. Tesi	p.tesi@rug.nl
PhD-students	
M.Z. Almuzakki	m.z.almuzakki@rug.nl
X. Bai	xiaoshan.bai@rug.nl
C. Cenedese	c.cenedese@rug.nl
N. Chan	n.p.k.chan@rug.nl
L. Chen	l.m.chen@rug.nl
X. Cheng	x.cheng@rug.nl
R. Cunha	r.f.cunha@rug.nl
M. Dresscher	m.dresscher@rug.nl
T. Esteves Rosa	t.esteves.rosa@rug.nl
S. Feng	s.feng@rug.nl
L. Gong	l.gong@rug.nl
A. Govaert	a.govaert@rug.nl
M. Guo	m.guo@rug.nl
M. Jeeninga	m.jeeninga@rug.nl
M.C. de Jong	matthijs.de.jong@rug.nl

name	e-mail address
C. de Jonge	chris.de.jonge@rug.nl
Y.A. Kapitanyuk	i.kapitaniuk@rug.nl
A. Luppi	a.luppi@rug.nl
E. Martirosyan	t.b.a.
M.A. Prawira Negara	m.a.prawira.negara@rug.nl
O. Portals Marin	o.portoles.marin@rug.nl
Y. Qin	yuzhen-qin@whu.edu.cn
M. Rotulo	m.rotulo@rug.nl
D. Senejohnny	d.senejohnny@rug.nl
M. Shakarami	m.shakarami@rug.nl
M. Shi	m.shi@rug.nl
T.W. Stegink	t.w.stegink@rug.nl
R. Tri Cahyono MSc	r.tri.cahyono@rug.nl
T. Van Damme	t.van.damme@rug.nl
M.A. Vasquez Beltran	m.a.vasquez.beltran@rug.nl
H. van Waarde	h.j.van.waarde@rug.nl
D. Wei	t.b.a
Z. Wu	t.b.a
W. Yao	w.yao@rug.nl
Q. Yang	q.k.yang@rug.nl
H. Zhang	hongyu.zhang@rug.nl
Researchers and postdocs	
L.P. Borja	l.p.borja.rosales@rug.nl
M. Cucuzzella	m.cucuzella@rug.nl
M. Guo	m.guo@rug.nl
Y. Kawano	y.kawano@rug.nl
K.C. Kosaraju	k.c.kosaraju@rug.nl
S. Pavlichkov	s.pavlichkov@rug.nl
V. Rostampour	v.rostampour@rug.nl
Z. Sun	zhonqi.sun@rug.nl
M. Ye	m.ye@rug.nl

RUG –Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence

Secretariat: Ineke Schelhaas (phone 050-3633379)
e-mail: Bernoulli.office@rug.nl
Member DISC management team: prof.dr. H.L. Trentelman

Staff	
Dr. B. Besselink	b.besselink@rug.nl
Prof.dr. K. Çamlibel	m.k.camlibel@rug.nl
Prof. dr. R. Carloni	r.carloni@rug.nl
Prof.dr. A.J. van der Schaft	a.j.van.der.schaft@rug.nl
Dr. S. Trenn	s.trenn@rug.nl
Prof.dr. H.L. Trentelman	h.l.trentelman@rug.nl

name	e-mail address
PhD-students	
A.B.M. Burohman	a.m.burohman@rug.nl
J. Eising	j.eising@rug.nl
S. Hossain	s.hossain@rug.nl
J. Jia	j.jia@rug.nl
J. Jiao	j.jiao@rug.nl
H. Liu	hongyun.liu@rug.nl
A. Mazumder	a.mazumder@rug.nl
V. Raveendranathan	v.raveendranathan@rug.nl
R. Reyes Baez	r.reyes-baez@rug.nl
A. Schmerbauch	a.e.m.schmerbauch@rug.nl
K. Sholmalzadeh	k.shomalzadeh@rug.nl
L. Wang	li.wang@rug.nl
C. Wang	chase.wang@rug.nl
P. Wijnbergen	p.wijnbergen@rug.nl

WU – Biobased Chemistry and Technology

Secretariat: Gerda Bos phone 0317-480694
e-mail: office.bct@wur.nl
Member DISC management team: prof. dr.ir. K.J. Keesman

Staff	
Prof.dr. H. Bitter	harry.bitter@wur.nl
Prof. dr.ir. K.J. Keesman	karel.keesman@wur.nl
Em. prof.dr.ir. G. van Straten	gerrit.vanstraten@wur.nl
WU-Biometris	
Dr. ir. J.D. Stigter	hans.stigter@wur.nl
Dr. ir. L.G. van Willigenbrug	gerard.vanwilligenburg@wur.nl
PhD-students	
E.Y.A. Amankwah MSc	emmanuel.amankwah@wur.nl
C.V.C. Geelen	caspar.geelen@wur.nl
H. Kandemir	hakan.kandemir@wur.nl
WU-Biometris	
D. Joubert	dominique.joubert@wur.nl
Researchers and postdocs	
Dr.ir. H.J. Cappon	hans.cappon@wur.nl
S. Goddek	simon.goddek@wur.nl

WU – Farm Technology

Secretariat: Miranda Tap – de Weme
e-mail: miranda.tap@wur.nl
Member DISC management team: Prof. dr. ir. E. van Henten

Staff	
Dr. ir. S.M.E. Derakshani	sayed.derakshani@wur.nl
Dr. M. Derks	marjolein.derks@wur.nl
Prof. dr. ir. P. Groot Koerkamp	peter.grootkoerkamp@wur.nl
Prof. dr. ir. EJ van Henten	eldert.vanhenten@wur.nl

name	e-mail address
Dr. ir. J.W Hofstee	janwillem.hofstee@wur.nl
Drs. A.P.H.M. Janssen	arni.janssen@wur.nl
Dr. G.W Kootstra	gert.kootstra@wur.nl
Dr. ir. S. van Mourik	simon.vanmourik@wur.nl
Dr. ir. A. van ‘t Ooster	bert.vantooster@wur.nl
R.J.C. van Ooteghem	rachel.vanooteghem@wur.nl
Dr. P.J.J. van der Tol	rik.vandertol@wur.nl
PhD-students	
R. Barth	ruud.barth@wur.nl
P.M. Blok	pieter.blok@wur.nl
F.P. Boogaard	frans.boogaard@wur.nl
Drs. I.D.E. van Dixhoorn	ingrid.vandixhoorn@wur.nl
H.J.C. van Dooren	hendrikjan.vandooren@wur.nl
N. Dorji	nedup.dorji@wur.nl
D. Kaljaca	dejan.kaljaca@wur.nl
D. Katzin	david.katzin@wur.nl
I.M. Krijger	inge.krijger@wur.nl
A.Marquez Aguilar	angel.marquezaguilar@wur.nl
F.D. Mondaca Duarte	francisco.mondacaduarte@wur.nl
T.M.J. Ruigrok	thijs.ruigrok@wur.nl
X. Song	xiangyu.song@wur.nl
H. Suh	hyun.suh@wur.nl
H.J.E. van Weeghel	ellen.vanweeghel@wur.nl
B. Zhou	bo.zhou@wur.nl
M. Zhou	mengting.zhou@wur.nl

UM – Department of Knowledge Engineering

secretariat Esther Breuls phone 043-3883494
email: esther.breuls@maastrichtuniversity.nl
Member DISC management team: prof.dr.ir. R.L.M. Peeters

Staff	
Dr. P.J. Collins	pieter.collins@maastrichtuniversity.nl
Dr. J.M.H. Karel	joel.karel@maastrichtuniversity.nl
Prof.dr.ir. R.L.M. Peeters	ralf.peeters@maastrichtuniversity.nl
Dr. K. Stankova	k.stankova@maastrichtuniversity.nl
PhD-students	
K. Schueller	k.schuller@maastrichtuniversity.nl

VU – Department of Mathematics

secretariat phone 020-5987700
Member DISC management team: prof.dr. A.C.M. Ran

Staff	
Prof.dr. M.A. Kaashoek,	m.a.kaashoek@vu.nl
Prof.dr. A.C.M. Ran	a.c.m.ran@vu.nl

name	e-mail address
TUD - DCSC	
Secretariat: Marieke Versloot-Bus phone 015-2782473	
e-mail:m.versloot-bus@tudelft.nl	
Member DISC management team: prof.dr.ir. M. Verhaegen, prof.dr.ir. B. De Schutter and prof. dr. J. Van Wingerden	
Staff	
Dr.ir. S. Baldi	s.baldi@tudelft.nl
Dr. K. Batselier	k. batselier@tudelft.nl
Dr.ir. A.J.J. van den Boom	a.j.j.vandenboom@tudelft.nl
Prof.dr.ir. B. De Schutter	b.deschutter@tudelft.nl
Dr. R. Ferrari	r.ferrari@tudelft.nl
Dr. ing. G. Giordano	g.giordano@tudelft.nl
Dr. S. Grammatico	s.grammatico@tudelft.nl
Dr.ir. T. Keviczky	t.keviczky@tudelft.nl
Dr. M. Kok	m.kok-1@tudelft.nl
Dr. M. Mazo Jr.	m.mazo@tudelft.nl
Dr. P. Mohajerin Esfahani	p.mohajerinesfahani@tudelft.nl
Dr. ing. R. Van de Plas	raf.vandeplas@tudelft.nl
Dr. C. Smith	c.s.smith@tudelft.nl
Dr. ir. E. Steur	e.steur@tudelft.nl
Prof. dr. G. Vdovine	g.v.vdovine@tudelft.nl
Prof.dr.ir. M. Verhaegen	m.verhaegen@tudelft.nl
Dr. ir. S. Wahls	s.wahls@tudelft.nl
Prof. dr.ir. J. van Wingerden	j.w.vanwingerden@tudelft.nl
Prof. dr. ir. N. van de Wouw	n.vandewouw@tudelft.nl
PhD-students	
Ir. T.E. Agbana	t.e.agbana@tudelft.nl
F. Alavi	f.alavi@tudelft.nl
J. Cnossen	j.p.cnossen@tudelft.nl
G. Delimpaltadakis	i.delimpaltadakis@tudelft.nl
B.M. Doekemeijer	b.m.doekemeijer@tudelft.nl
R. Doelman LLB MSc	r.doelman@tudelft.nl
J.E. Fransman MSc.	j.e.fransman@tudelft.nl
J.A. Frederik	J.A.Frederik@tudelft.nl
E. de Gelder	e.degelder@tudelft.nl
G. Gleizer	g.gleizer@tudelft.nl
A. Gupta	A.Gupta-3@tudelft.nl
J.L.G. Lago Garcia	j.lagogarcia@tudelft.nl
S. Liu MSc	s.liu-1@tudelft.nl
M. Lv	m.lyu@tudelft.nl
N. Moustakis	n.moustakis@tudelft.nl
Ir. S.P. Mulders MSc	s.p.mulders@tudelft.nl
T. Pippia	t.m.pippia@tudelft.nl
P.J. Piscaer	p.j.piscaer@tudelft.nl
P.J. Prins	p.j.prins@tudelft.nl

name	e-mail address
A. Sharifi Kolarijani MSc	a.sharifikolarijani@tudelft.nl
M.A. Sharifi Kolarijani	m.a. sharifikolarijani@tudelft.nl
B. Sinquin	b.sinquin@tudelft.nl
C.F. Verdier	c.f.verdier@tudelft.nl
J. Xu BSc	j.xu-3@tudelft.nl
S. Yuan	s.yuan-1@tudelft.nl
Researchers and postdocs	
Dr. J.M. Dominguez Frejo	j.r.dominguezfrejo@tudelft.nl
Dr. H. Gong	h.gong@tudelft.nl
Dr. H.T. Nguyen	h.t.nguyen-3@tudelft.nl
P. Pozzi	p.pozzi@tudelft.nl
Dr. A.V. Proskurnikov	a.v.proskurnikov@tudelft.nl
Dr. O.A. Soloviev	o.a.soloviev@tudelft.nl
Dr. ir. Y. Wang	yihui.wang@tudelft.nl

TUD – Cognitive Robotics (CoR)

Secretariat: Hanneke Hustinx and Karin van Tongeren
e-mail: secretariaat-cor-3mE@tudelft.nl
Member DISC management team: prof. dr. ir. H. Hellendoorn and prof.dr. R. Babuska

Staff	
Prof. dr. ir. D.A. Abbink	d.a.abbink@tudelft.nl
Dr. J. Alonso Mora	j.alonsoMora@tudelft.nl
Prof. dr. R. Babuska	r.babuska@tudelft.nl
Dr. ir. E.R. Boer	e.r.boer@tudelft.nl
Prof. dr. D.M. Gavrila	d.gavrila@tudelft.nl
Dr. ir. R. Happee	r.happee@tudelft.nl
Prof. dr. ir. H. Hellendoorn	j.hellendoorn@tudelft.nl
Dr. ing. J. Kober	j.kober@tudelft.nl
Dr. J.F.P. Kooij	j.f.p.kooij@tudelft.nl
Dr. W. Pan	wei.pan@tudelft.nl
Dr. B. Shyrokau	b.shyrokau@tudelft.nl
Prof. dr. ir. M. Wisse	m.wisse@tudelft.nl
PhD students	
S. Barendswaard	s.barendswaard@tudelft.nl
T. Bates	t.bates@tudelft.nl
T.D. de Bruin	t.d.debruin@tudelft.nl
J.F.M. Domhof	j.f.m.domhof@tudelft.nl
B.F. Ferreira de Brito	bruno.debrito@tudelft.nl
T.M. Hehn	t.m.hehn@tudelft.nl
T. Irmak	t.irmak@tudelft.nl
S.B. Kolekar	s.b.kolekar@tudelft.nl
Z. Lu	z.lu@tudelft.nl
A. Palffy	a.palffy@tudelft.nl
T. Melman	t.melman@tudelft.nl
E.A.I. Pool	e.a.i.pool@tudelft.nl

name	e-mail address
L.F. van der Spaa	l.f.vanderspaa@tudelft.nl
J.C.J. Stapel	j.c.j.stapel@tudelft.nl
H. Zhu	h.zhu@tudelft.nl
Researchers and postdocs	
M. Cap	m.cap-2@tudelft.nl
C.E. Celemin Paez	c.e.celeminPaez@tudelft.nl
L. Ferranti	l.ferranti@tudelft.nl
F.B. Flohr	f.b.flohr@tudelft.nl
C. Hernandez Corbato	c.h.corbato@tudelft.nl

TUD – Department of Applied Mathematics

secretariat: Dorothée Engering phone 015-2783883
e-mail: d.w.m.engering@tudelft.nl
Member DISC management team: prof.dr.ir. A.W. Heemink

Staff	
Prof.dr.ir. A.W. Heemink	a.w.heemink@tudelft.nl
Dr.ir. J.G. Maks	j.g.maks@tudelft.nl
Em. prof.dr.ir. G.J. Olsder	g.j.olsder@tudelft.nl
Em. prof.dr.ir. J.H. van Schuppen	j.h.vanschuppen@tudelft.nl
Dr. J.W. van der Woude	j.w.vanderwoude@tudelft.nl
PhD-students	
M. Adibi	m.adibi@tudelft.nl
J. Jin	j.jin-2@tudelft.nl
S. Lopez Restrepo	s.lopezrestrepo@tudelft.nl
A.R.P.J. Vijn	a.r.p.j.vijn@tudelft.nl
C. Xiao	c.xiao@tudelft.nl
A. Yarce Botero	a.yarcebotero@tudelft.nl

TUD – Faculty of Aerospace Engineering

Secretariat: Bertine Markus phone 015-2782094
e-mail: b.m.markus@tudelft.nl
Member DISC management team: prof.dr.ir. M. Mulder

Staff	
Dr.ir. C. Borst	c.borst@tudelft.nl
Dr. Q.P. Chu	q.p.chu@tudelft.nl
Dr.G.C.H.E. de Croon	g.c.h.e.decroon@tudelft.nl
Dr.ir. J. Ellerbroek	j.ellerbroek@tudelft.nl
Prof.dr.ir. J.M. Hoekstra	j.m.hoekstra@tudelft.nl
Dr.ir. E. van Kampen	e.vankampen@tudelft.nl
Em. prof.dr.ir. J.A. Mulder,	j.a.mulder@tudelft.nl
Prof.dr.ir. M. Mulder	m.mulder@tudelft.nl
Ir. T.J. Mulder	t.j.mulder@tudelft.nl
Dr.ir. M.M. van Paassen	m.m.vanpaassen@tudelft.nl
Dr.ir. M.D. Pavel	m.d.pavel@tudelft.nl
Dr.ir. D.M. Pool	d.m.pool@tudelft.nl

name	e-mail address
Dr. ir. A.C. in ‘t Veld	a.c.intveld@tudelft.nl
Dr.ir. C.C. de Visser	c.c.devisser@tudelft.nl
PhD-students	
Ir. P. Acquatella	p.j.acquatellabustillo@tudelft.nl
E. Akel	e.akel@tudelft.nl
I. Arush	i.arush@tudelft.nl
Ir. D. Van Baelen	d.vanbaelen@tudelft.nl
Ir. K. Capiot	k.capiot-1@tudelft.nl
Ir. D. Cleij	d.cleij@tudelft.nl
M. Coppola	m.coppola@tudelft.nl
Ir. T. van Dijk	j.c.vandijk-1@tudelft.nl
Ir. M. Doole	m.m.doole@tudelft.nl
Y.B. Eisma	y.b.eisma@tudelft.nl
Ir. L. van Eykeren	l.vaneykeren@tudelft.nl
D. Friesen	d.friesen@tudelft.nl
W. Fu, MSc	w.fu-1@tudelft.nl
Y. Huang	y.huang-2@tudelft.nl
C. Janke	c.janke@tudelft.nl
J. Junell	j.l.junell@tudelft.nl
R.E. Klomp	r.e.klomp@tudelft.nl
H.M. Landman	h.m.landman@tudelft.nl
S.Li, MSC	s.li-4@tudelft.nl
Ir. J.B. Maas	j.b.maas@tudelft.nl
Ir. K.N. McGuire	k.n.mcguire@tudelft.nl
Ir. G.A. Mercado Velasco	g.a.mercadovelasco@tudelft.nl
I.C. Metz, MSC.	i.c.metz@tudelft.nl
Ir. I. Miletovic	i.miletovic@tudelft.nl
Ir. N. Nabi	h.n.nabi@tudelft.nl
D.A. Olejnik	d.a.olejnik@tudelft.nl
Ir. Federico Paredes Valles	f.paradesvalles@tudelft.nl
Ir. J.L. de Prins	johan.l.deprins@boeing.com
J.P.Reitsema	j.p.reitsema@tudelft.nl
I. Rudnyk	i.rudnyk@tudelft.nl
N. Ruseno	n.ruseno@tudelft.nl
P.F. Scaramuzzino	p.f.scaramuzzino@tudelft.nl
Ir. K.Y.W. Scheper	k.y.w.scheper@tudelft.nl
B. Sun	b.sun-1@tudelft.nl
S. Sun	s.sun-4@tudelft.nl
J. Sun, MSc	J.Sun-1@tudelft.nl
Ir. E. Sunil	e.sunil@tudelft.nl
Ir. M. Tielrooij	m.tielrooij@tudelft.nl
T. Visser`	t.visser-1@tudelft.nl
Ir. C. de Wagter	c.dewagter@tudelft.nl
X. Wang	x.wang-6@tudelft.nl
Y. Xu	y.xu-6@tudelft.nl
Y. Yu	y.yu-2@tudelft.nl

name	e-mail address
Y. Zhang, MSc.	ye.zhang@tudelft.nl

TU/e – Department of Electrical Engineering

Secretariat: Diana Heijnerman phone 040-2472300
e-mail: secretariaat.cs@tue.nl
Member DISC management team: prof.dr.ir. P.M.J. Van den Hof

Staff	
Prof.dr.ir. A.C.P.M. Backx	a.c.p.m.backx@tue.nl
Prof.dr.ir. H.J. Bergveld	h.j.bergveld@tue.nl
Em. prof.dr.ir. P.P.J. v.d. Bosch,	p.p.j.v.d.bosch@tue.nl
Prof.dr.ir. H. Butler	h.butler@tue.nl
Dr.ir. M.C.F. Donkers	m.c.f.donkers@tue.nl
Dr. S. Haesaert	s.haesaert@tue.nl
Dr. M. Lazar	m.lazar@tue.nl
Dr. L. Ozkan	l.ozkan@tue.nl
Prof. dr. ir. J.F.M. Schoukens	j.f.m.schoukens@tue.nl
Dr. R. Toth	r.toth@tue.nl
Prof.dr.ir. P.M.J. Van den Hof	p.m.j.vandenhof@tue.nl
Prof.dr. S. Weiland	s.weiland@tue.nl
PhD-students	
H.P.G.J. Beelen MSc	h.p.g.j.beelen@tue.nl
G. Belgioiso MSC	g.belgioioso@tue.nl
T.A.H. Bloemers	t.a.h.bloemers@tue.nl
C.P. Bosman Barros	c.p.bosman.barros@tue.nl
A. Das	am.das@tue.nl
Ir. J. Hanema MSc	j.hanema@tue.nl
F.S.J. Hoekstra	f.s.j.hoekstra@tue.nl
Ir. D.P.M. van den Hurk	d.p.m.v.d.hurk@tue.nl
Y. Kasemsinsup MSc	y.kasemsinsup@tue.nl
Z. Khalik	z.khalik@tue.nl
D. Khandelwal	d.khandelwal@tue.nl
L. Kivits	e.m.m.kivits@tue.nl
Ir. D. Lou	d.lou@tue.nl
C. Mendez-Blanco	c.s.mendez.blanco@tue.nl
R.W.H. Merks MSc	r.w.h.merks@tue.nl
G.P. Padilla Cazar	g.p.padilla.cazar@tue.nl
I. Proimadis MSc	i.proimadis@tue.nl
K. Ramaswamy	k.r.ramaswamy@tue.nl
G. Sales Mazzoccante	g.sales.mazzocante@tue.nl
S. Shi	s.shi@tue.nl
T.R.V. Steentjes	t.r.v.steentjes@tue.nl
H.H.M. Weerts	h.h.m.weerts@tue.nl
Researchers and postdocs	
Dr. G. Bottegal	g.bottegal@tue.nl
Dr. C. Cox	p.b.cox@tue.nl
Dr. D.L. Danilov	d.l.danilov@tue.nl
Dr. ir. J.H.A. Ludlage	j.h.a.ludlage@tue.nl

name	e-mail address
Dr. M. Porru	m.porru@tue.nl
Dr. M. Schoukens	m.schoukens@tue.nl

TU/e – Dynamics and Control

secretariat D&C: Geertje Janssen-Dols & Ingrid van Maaren
e-mail: secretariaat.DC@tue.nl
Member DISC management team: prof.dr. H. Nijmeijer and prof. dr. ir. N. v.d. Wouw

Staff	
Prof. dr. ir. I.J.B.F. Adan	i.adan@tue.nl
Dr.ir. I.J.M. Besselink	i.j.m.besselink@tue.nl
Dr.ir. R.H.B. Fey	r.h.b.fey@tue.nl
Dr.ir. M. Heertjes	m.f.heertjes@tue.nl
Dr. Ir. A.A.J. Lefeber	a.a.j.lefeber@tue.nl
Prof. dr.ir. I. Lopez	i.lopez@tue.nl
Prof.dr. H. Nijmeijer	h.nijmeijer@tue.nl
Dr. Ir. J. Ploeg	j.ploeg@tue.nl
Dr. A. Pogromsky	a.pogromski@tue.nl
Dr.ir. P.C.J.N. Rosielle	p.c.j.n.rosielle@tue.nl
Dr. A. Saccon	a.saccon@tue.nl
Dr. H. Sadeghian Marnani	h.sadeghian.marnani@tue.nl
Dr. ir. E. Steur	e.steur@tue.nl
Prof.dr.ir. N. v.d. Wouw	n.v.d.wouw@tue.nl
Prof. dr. Ir. P.W.A. Zegelaar	p.w.a.zegelaar@tue.nl
Prof.dr. H.J. Zwart	h.j.zwart@tue.nl
PhD-students	
A.G. Aribowo	a.g.aribowo@tue.nl
A. Bayuwindra	a.bayuwindra@tue.nl
C.J.J. Beckers	c.j.j. beckers@tue.nl
R. Beerens	r.beerens@tue.nl
B.J. Caasenbrood	b.j.caasenbrood@tue.nl
G. de Carolis	g.d.carolis@tue.nl
I.T. Castanedo Guerra	i.t.castanedo.guerra@tue.nl
S.J.A.M. van den Eijnden	s.j.a.m.v.d.eijnden@tue.nl
L. Hazeleger	l.hazeger@tue.nl
R.B.A. van Hoek	r.b.a.v.hoek@tue.nl
F. Hoogeboom	f.n.hoogeboom@tue.nl
K. Kural	k.kural@tue.nl
R. Lensvelt	r.lensvelt@tue.nl
Y. Ma	y.ma1@tue.nl
V. Mazulina	v.mazulina@tue.nl
A.I. Morales Medina MSc	a.i.morales.medina@tue.nl
S. Naderilordejani	s.naderilordejani@tue.nl
K. Peeters	k.peeters@tue.nl
J. Reinders	j.m.f.reinders@tue.nl
I. F. Rodrigues	i.f.rodrigues@tue.nl
K.O. Rogov	k.rogov@tue.nl
Ir. W.S. Schinkel	w.s.schinkel@tue.nl
W.J. Scholte	w.j.scholte@tue.nl

name	e-mail address
M.F. Shakib	m.f.shakib@tue.nl
S. Tashakori	s.tashakori@tue.nl
J. Thomas	j.thomas@tue.nl
D. Veldman	d.w.m.veldman@tue.nl
Q.J.T. Voortman	q.j.t.voortman@tue.nl
C. Wang	c.wang1@tue.nl
H. Xing	h.xing@tue.nl
Researchers and postdocs	
Dr.ir. T.P.J. van der Sande	t.p.j.v.d.sande@tue.nl

TU/e – Control Systems Technology

secretariat CST: Nancy Wagemakers
e-mail: cst@tue.nl
Member DISC management team section CST prof.dr.ir. M. Steinbuch and prof dr. ir. M. Heemels.

Staff	
Prof. dr. M.R. de Baar	m.r.d.baar@tue.nl
Prof. dr. H.P.J. Bruyninckx	h.p.j.bruyninckx@tue.nl
Prof.dr.ir. W.P.M.H. Heemels	m.heemels@tue.nl
Dr.ir. T. Hofman	t.hofman@tue.nl
Dr.ir. A.G. de Jager	a.g.d.jager@tue.nl
Dr.ir. M.J.G. v.d. Molengraft	m.j.g.v.d.molengraft@tue.nl
Dr.ir. T.A.E. Oomen	t.a.e.oomen@tue.nl
Dr.ir. P.C.J.N. Rosielle	p.c.j.n.rosielle@tue.nl
Prof.dr.ir. M. Steinbuch	m.steinbuch@tue.nl
Prof. dr. ir. J.P.M.B. Vermeulen	j.p.m.b.vermeulen@tue.nl
Dr.ir. F.P.T. Willems	f.p.t.willems@tue.nl
Dr. ir. G. Witvoet	g.witvoet@tue.nl
PhD-students	
A.R.P. Andriën	a.r.p.andrien@tue.nl
M.H.B.I. Balaghiinaloo	m.balaghiinaloo@tue.nl
Ir. M.A. Beijen	m.a.beijen@tue.nl
L.L.G. Blanken	l.l.g.blanken@tue.nl
T.C. Blanken	t.c.blanken@tue.nl
H.L. Chen	h.l.chen@tue.nl
R. Cobbenhagen	a.t.j.r.cobbenhagen@tue.nl
D. Deenen	d.a.deenen@tue.nl
M. Dolatabadi Farahani	m.dolatabadi.farahani@tue.nl
Y.G.M. Douven	y.g.m.douven@tue.nl
E. Evers	e.evers@tue.nl
C.A. Fahdzyana	c.a.fahdzyana@tue.nl
Ir. M.H.M. van Gastel	m.h.m.v. gastel@tue.nl
M.A. Goorden	m.a.goorden@tue.nl
Ir.T.M. Hafkamp	t.m.hafkamp@tue.nl
S.J.H. Heijmans	s.h.j.heijmans@tue.nl
R.W.M. Hendrickx	r.w.m.hendrickx@tue.nl
W. Houtman	w.houtman@tue.nl

name	e-mail address
Ir. H.B. Koolmees	h.b.koolmees@tue.nl
W.J.P. Kuijpers	w.j.p.kuijpers@tue.nl
R. Mohan	r.mohan@tue.nl
N.F.M. Mooren	n.f.m.mooren@tue.nl
P. Mulders	p.j.a.m.mulders@tue.nl
S. Prakash	s.prakash@tue.nl
A. Rashidinejad	a.rashidinejad@tue.nl
T. Ravensbergen	t.ravensbergen@tue.nl
F.F.H. Reijnen	f.f.h.reijnen@tue.nl
Ir. R. de Rozario	r.d.rozario@tue.nl
Ir. N.W.A. Strijbosch	n.w.a.strijbosch@tue.nl
Ir. F.J.R. Verbruggen	f.j.r.verbruggen@tue.nl
R.J. Voorhoeve	r.j.voorhoeve@tue.nl
C. Wei	c.wei.1@tue.nl
R. van der Weijst	r.v.d.weijst@tue.nl
L. Xia	l.xia1@tue.nl
Researchers and postdocs	
Dr. C.A. Lopez Martinez	c.a.lopez.martinez@tue.nl

UT – Department of Robotics and Mechatronics
secretariat: Jolanda Boelema-Kaufmann phone 053-4892626
e-mail: ram@utwente.nl
Member DISC management team: prof.dr.ir. S. Stramigioli

Staff	
Dr.ir. M. Abayazid	m.abayazid@utwente.nl
Dr.ir. P.C. Breedveld	p.c.breedveld@utwente.nl
Dr.ir. J.F. Broenink	j.f.broenink@utwente.nl
Dr.ir. E.C. Dertien	e.c.dertien@utwente.nl
Dr. ir. D. Dresscher	d.dresscher@utwente.nl
Dr. ir. J.B.C Engelen	j.b.c.engelen@utwente.nl
Dr. ir. G.A. Folkertsma	g.a.folkertsma@utwente.nl
Prof.dr.ir. S. Stramigioli	s.stramigioli@utwente.nl
Dr. ir. T.J.A. de Vries	t.j.a.devries@utwente.nl
PhD-students	
N. Botteghi MSC	n.botteghi@utwente.nl
T.G. Broenink MSC	t.g.broenink@utwente.nl
V. Groenhuis MSc	v.groenhuis@utwente.nl
R. Hashem MSc	r.a.m.rashadhashem@utwente.nl
H. Noshahri MSC	h.noshahri@utwente.nl
K.J. Russcher MSc	k.j.russcher@utwente.nl
M.K. Welleweerd Msc	m.k.welleweerd@utwente.nl
G.J.W. Wolterink MSc	g.j.w.wolterink@utwente.nl
H.W. Wopereis MSc	h.w.wopereis@utwente.nl
Researchers and postdocs	
Dr. ir. S.S. Groothuis	s.s.groothuis@utwente.nl
Dr. M. Shurrab	m.shurrab@utwente.nl
Dr. F. J. Siepel	f.j.siepel@utwente.nl
Dr. B. Sirmaçek	b.sirmacek@utwente.nl

name	e-mail address

UT – Department of Applied Mathematics

E-mail secretariat: info-sacs-ewi@utwente.nl
Member DISC management team: prof.dr. H.J. Zwart

Staff	
Dr. P.K. Mandal	p.k.mandal@utwente.nl
Dr. G. Meinsma	g.meinsma@utwente.nl
Dr. J.W. Polderman	j.w.polderman@utwente.nl
Prof.dr. A.A. Stoorvogel	a.a.stoorvogel@utwente.nl
Prof.dr. H.J. Zwart	h.j.zwart@utwente.nl
PhD-students	
F. Acciani	f.acciani@utwente.nl
Researchers and postdocs	
Dr. W.S. Rossi	w.s.rossi@utwente.nl
Dr. M. Mamunuzzaman	m.mamunuzzaman@utwente.nl
Dr. S.F. Sharifi	s.f.sharifi@utwente.nl

UT – Department of Mechanics of Solids, Surfaces & Systems

secretariat: Debbie Zimmerman van Woesik phone 053-4892460
e-mail: d.b.zimmermanvanwoesik@utwente.nl
Member DISC management team: dr.ir. W.B.J. Hakvoort

Staff	
Dr.ir. R.G.K.M. Aarts	r.g.k.m.aarts@utwente.nl
Dr. ir. W.B.J. Hakvoort	w.b.j.hakvoort@utwente.nl

UT- Department of Biomechanical Engineering

secretariat: Lianne Bode and Jeanine Lodeweges-de Vries
email: secretariat-bw-ctw@utwente.nl
Member DISC management team: prof. dr. ir. H.F.J.M. Koopman

Staff	
Dr. E.H.F. van Asseldonk	e.h.f.vanasseldonk@utwente.nl
Dr.ir. D. van de Belt	d.vandebelt@utwente.nl
Ir. A. Bergsma	a.bergsma@utwente.nl
Dr. R. Dubbeldam PT, MSC	r.dubbeldam@utwente.nl
Prof. dr. J.G. Grandjean	j.g.grandjean@utwente.nl
Ir. E.E.G. Hekman	e.e.g.hekman@utwente.nl
Dr. ir. A.Q.L. Keemink	a.q.l.keemink@utwente.nl
Prof.dr.ir. H. van der Kooij	h.vanderkooij@utwente.nl
Prof. dr. ir. H.F.M.J. Koopman	h.f.j.m.koopman@utwente.nl
M.A. Marra, MSc	m.a.marra@utwente.nl
L. Masia, PhD	l.masia@utwente.nl
Dr. S. Misra	s.misra@utwente.nl
Dr. G.B. Prange	g.b.prange@utwente.nl
Dr. J. Reenalda	j.reenalda@utwente.nl
Prof. dr. J.S. Rietman	j.s.rietman@utwente.nl
Dr. ir. J. Rouwkema	j.rouwkema@utwente.nl

name	e-mail address
M. Sartori	m.sartori@utwente.nl
Dr. Ir. A.A. Schouten	a.c.schouten@utwente.nl
Prof. dr. ir. N.J.J. Verdonschot	n.verdonschot@utwente.nl
Prof. dr. ir. G.J. Verkerke	g.j.verkerke@utwente.nl
PhD-students	
Ir. P.G.M Bakker	p.g.m.bakker@utwente.nl
R. Bayoglu	r.bayoglu@utwente.nl
N.W.M. Beckers MSc	n.w.m.beckers@utwente.nl
H. Chen MSc	h.chen-1@utwente.nl
G.V. Durandau	g.v.durandau@utwente.nl
S.S. Fricke MSc	s.s.fricke@utwente.nl
A.M. Geers MSc	a.m.geers@utwente.nl
Ir. M.E. Grootens	m.e.grootens@utwente.nl
C.J.W. Haarman	c.j.w.haarman@utwente.nl
F.R. Halfwerk	f.r.halfwerk@utwente.nl
C.M. Heunis	c.m.heunis@utwente.nl
M. Kaya MSc	m.kaya@utwente.nl
F. Khan	f.khan@utwente.nl
M. van Mierlo	m.vanmierlo@utwente.nl
S. Mohanty	s.mohanty@utente.nl
K. Nizamis MSC	k.nizamis@utwente.n
F. Ongaro MSc	f.ongaro@utwente.nl
P. Padmanaban, MSc	p.padmanaban@utwente.nl
G. Philips Furtado	g.phillipsfurtado@utwente.nl
W.F. Rampeltshammer	w.f.rampeltshammer@utwente.nl
D. Rana	d.rana@utwente.nl
J. Sikorski MSc	j.sikorski@utwente.nl
F. Sojoodi Farimani MSc	f.s.farimani@utwente.nl
Ir. K. Staman	k.staman@utwente.nl
F. Stein	f.stein@utwente.nl
M.J.B. Tenniglo	m.j.b.tenniglo@utwente.nl
V. Trikalitis	v.trikalitis@utwente.nl
M. Tschiersky	m.tschiersky@utwente.nl
R.C. Van't Veld	r.c.vantveld@utwente.nl
S. Verros MSc	s.verros@utwente.nl
J. Zhang	j.zhang@utwente.nl
Researchers and postdocs	
C. Bayon Calderon	c.bayoncalderon@utwente.nl
T.H.J. Brug	t.h.j.brug@utwente.nl
Dr.ir. R. Fluit	r.fluit@utwente.nl
V. Kalpathy Venkiteswaran	v.kalpathyvenkiteswaran@utwente.nl
A.I.R. Kottink	a.i.r.hutten@utwente.nl
Dr. ir. G. van Oort	g.vanoort@utwente.nl
G. Overweg MSc	g.overweg@utwente.nl
N.Salehi Nik, MSc	n.salehinik@utwente.nl

name	e-mail address
Dr. S. Scheggi	s.scheggi@utwente.nl
Dr. A.M.J. Sprengers	a.m.j.sprengers@utwente.nl
A.J. Veale	a.j.veale@utwente.nl
Dr. Ir. M. Wessels	m.wessels@utwente.nl