31st MEDITERRANEAN CONFERENCE ON CONTROL & AUTOMATION (MED'23)

June 26 – 29, 2023
GrandResort
Limassol, Cyprus

FINAL PROGRAM & BOOK OF ABSTRACTS

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TECHNICAL CO-SPONSORSHIP

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HISTORY OF 31 YEARS OF MED CONFERENCES

31st Mediterranean Conference on Control and Automation (MED'23)
June 26 – 29, 2023, Limassol, Cyprus
GC: Christos Panayiotou
HC: Panos J. Antsaklis, Zalman Palmor
PC: Vicenç Puig, Marcin Witczak
Plenaries: Karl H. Johansson, Jing Sun, Kostas Alexis

30th Mediterranean Conference on Control and Automation (MED'22)
June 28-July 1, 2022, Vouliagmeni-Athens, Greece
GC: Kimon P. Valavanis, Maria Prandini
HC: Panos J. Antsaklis, Zalman Palmor
PC: Andrea Monteriù, Alessandro V. Papadopoulos
Plenaries: Frank Allgöwer, Sandra Hirche, John Lygeros, Nick Sigrimis

29th Mediterranean Conference on Control and Automation (MED'21)
June 22-25, 2021, Bari, Italy
GC: Mariagrazia Dotoli, Laura Giarrè
PC: Laura Giarrè, Elisa Franco
Plenaries: Anuradha Annaswamy, Anna Stefanopoulou, Giuseppe Notarstefano

28th Mediterranean Conference on Control and Automation (MED'20)
September 16-18, 2020, Saint-Raphaël, France
GC: Didier Maquin
PC: Kimon P. Valavanis, Didier Theilliol
Plenaries: Alexander Medvedev, Daniel Zelazo, Charles Poussot-Vassal

27th Mediterranean Conference on Control and Automation (MED'19)
July 1-4, 2019, Akko, Israel
GC: Tal Shima, Zalman Palmor
PC: Leonid Mirkin, Daniel Zelazo
Plenaries: Shimon Marom, Martina Maggio, Florian Dörfler

26th Mediterranean Conference on Control and Automation (MED'18)
June 19-22, 2018, Zadar, Croatia
GC: Stjepan Bogdan, Sandra Hirche
HC: Panos J. Antsaklis, Kimon Valavanis
PC: Nikola Miskovic, Roberto Galeazzi
Plenaries: Bart De Moor, Maryam Kamgarpour, Yasamin Mostofi

25th Mediterranean Conference on Control and Automation (MED'17)
July 3-6, 2017, Valletta, Malta
GC: Simon G. Fabri, Didier Theilliol
PC: Marvin Bugeja, Xenofon Koutsoukos
Plenaries: Raffaello D'Andrea, Visakan Kadirkamanathan, Marios Polycarpou

24th Mediterranean Conference on Control and Automation (MED'16)
June 21-24, 2016, Athens, Greece
GC: Panos J. Antsaklis, Kimon P. Valavanis
PC: Didier Theilliol, Anthony Tzes
Plenaries: Alessandro Astolfi, David Harari, Yannis Phillis, Roland Siegwart, Roberto Tempo

23rd Mediterranean Conference on Control and Automation (MED'15)
June 16-19, 2015, Torremolinos, Spain
GC: Joseba Quevedo, Victor Fernando Muñoz
PC: Sebastian Dormido, Didier Maquin
Plenaries: Tore Hägglund, Manuel Silva, Magnus Egerstedt

22nd Mediterranean Conference on Control and Automation (MED'14)
June 16-19, 2014, Palermo, Italy
GC: Laura Giarré, Francesco Alonge
PC: Giuseppe Conte
Plenaries: Stephen P. Boyd, Munther A. Dahleh, Mustafa Khammash

21st Mediterranean Conference on Control and Automation (MED'13)
June 25-28, 2013, Platanias-Chania, Crete, Greece
GC: Panos J. Antsaklis, Kimon P. Valavanis
PC: Nikos C. Tsourveloudis
Plenaries: Anibal Ollero, Frank L. Lewis, Thomas Parisini, Petros A. Ioannou

20th Mediterranean Conference on Control and Automation (MED'12)
July 3-6, 2012, Barcelona, Spain
GC: Joseba Quevedo
PC: Pedro Albertos
Plenaries: Mario Sznaier, Sergio Bittanti, Alicia Casais

19th Mediterranean Conference on Control and Automation (MED'11)
June 20-23, 2011, Aquis Corfu Holiday Palace, Corfu, Greece
GC: Anthony Tzes
PC: George Pappas
Plenaries: Roger Goodall, John S. Baras, Claire Tomlin, John N. Tsitsiklis

18th Mediterranean Conference on Control and Automation (MED'10)
June 23-25, 2010, Congress Palace, Marrakech, Morocco
GC: Abdellah Benzaouia & Ahmed El Hajjaji
PC: Dominique Sauter
Plenaries: Marcel Staroswiecki, Christos G. Cassandras, Zalman J. Palmor, Antonio Sala

17th Mediterranean Conference on Control and Automation (MED'09)
June 24-26, 2009, Makedonia Palace, Thessaloniki, Greece
GC: Vassilios Petridis, Frank L. Lewis
PC: Thomas Parisini
Plenaries: Petros Ioannou, Jie Huang, Tony Vardulakis, Libor Kral, Alkis Konstantellos

16th Mediterranean Conference on Control and Automation (MED'08)
June 25-27, 2008, Congress Center, Ajaccio-Corsica, France
GC: Dominique Sauter
HC: Panos Antsaklis
PC: Ron Patton
Plenaries: Miroslav Krstic, Silviu-Iulan Niculescu, Andrea Bobbio

15th Mediterranean Conference on Control and Automation (MED'07)
June 27-29, 2007, Divani Caravel Hotel, Athens, Greece
GC: Panos Antsaklis, Kimon Valavanis

PC: Zdenko Kovacic
Plenaries: Mike J. Grimble, Joerg Raisch, Karl Henrik Johansson, Tariq Samad

14th Mediterranean Conference on Control and Automation (MED'06)
June 28-30, 2006, Università Politecnica delle Marche, Ancona, Italy
GC: Giuseppe Conte, Marcello Napolitano
Plenaries: Siva S. Banda, Kevin M. Passino, Gilead Tadmor, Bernd R. Noack, Marek Morzynski

13th Mediterranean Conference on Control and Automation (MED'05)
June 27-29, 2005, Hawaii Grand Hotel & Resort, Limassol, Cyprus
GC: Marios M. Polycarpou
PC: Michael A. Demetriou
Plenaries: Christos Cassandras, Eduardo Sontag, Julie Chen

12th Mediterranean Conference on Control and Automation (MED'04)
June 6-9, 2004, Kusadasi, Turkey
GC: Okyay Kaynak
HC: Tamer Basar
PC: Petros Loannou, Robert King, Li Qiu
Plenaries: Oussama Khatib, Xi-Ren Cao, George J. Vachtsevanos, Umit Ozgüner

11th Mediterranean Conference on Control and Automation (MED'03)
June 18-20, 2003, Rodos Palace Hotel, Rhodes, Greece
GC: Frank L. Lewis, Kimon P. Valavanis
PC: Stjepan Bogdan
Plenaries: Panos Antsaklis, Gerd Hirzinger, Manfred Morari, Shankar Sastry

10th Mediterranean Conference on Control and Automation (MED'02)
July 9-13, 2002, Lisbon, Portugal
GC: Joao J.S. Sentieiro
PC: Michael Athans
Plenaries: H. I. Christensen, J. C. Doyle, P. Varaiya, O. Faugeras, R. Kumar, M. A. Dahleh, E. Crawley, D. G. Luenberger

9th Mediterranean Conference on Control and Automation (MED'01)
June 27-29, 2001, Hotel Excelsior, Dubrovnik, Croatia
GC: Zoran Vukic, Kimon P. Valavanis
PC: Zdenko Kovacic, Kostas J. Kyriakopoulos
Plenaries: Michael Athans, Petar Kokotovic, Murat Arcak, Vladimir Muljevic, Lotfi Zadeh

8th Mediterranean Conference on Control and Automation (MED'00)
July 17-19, 2000, University of Patras, Rio, Greece
GC: Peter P. Groumpos, Panos Antsaklis
PC: Nick T. Koussoulas
Plenaries: George Metakides, Shankar Sastry

7th Mediterranean Conference on Control and Automation (MED'99)
June 28-30, 1999, Dan Panorama Hotel, Haifa, Israel
GC: Zalman J. Palmor, Howard Kaufman
PC: Arie Feuer
Plenaries: Graham Goodwin, Michael Heymann, Stephen Boyd, Yaakov Bar-Shalom, David Bayard

6th Mediterranean Conference on Control and Automation (MED'98)
June 9-11, 1998, Hotel Carlos V, Alghero, Sardinia, Italy
GC: Antonio Tornambe
PC: Giuseppe Conte

5th Mediterranean Conference on Control, Systems (MED'97)
July 21-23, 1997, Phaethon Beach Hotel Club, Paphos, Cyprus
GC/PC: Theodore E. Djaferis
Keynote: Sanjoy Mitter

4th Mediterranean Symposium on Control and Automation (MED'96)
June 10-13, 1996, Louis Maleme Beach Hotel, Chania, Crete, Greece
GC: Frank L. Lewis, Petros P. Groumpos, Paris N. Paraskevopoulos
HC: Panos J. Antsaklis
PC: Kostas Kyriakopoulos, Petros G. Voulgaris
Plenaries: Frank L. Lewis, Dave Boland, Vladimir Kucera

3rd Mediterranean Symposium on Control and Automation (MED'95)
July 11-13, 1995, Limassol, Cyprus
GC: Petros A. Ioannou
PC: Frank L. Lewis

2nd Mediterranean Symposium on New Directions in Control and Automation (MED'94)
June 19-21, 1994, Louis Maleme Beach Hotel, Chania, Crete, Greece
GC: Kimon P. Valavanis
HC: George N. Saridis
PC: Frank L. Lewis

1st Mediterranean Symposium on New Directions in Control Theory, Applications (MED'93)
June 21-23, 1993, Handris Hotel, Maleme, Chania, Crete, Greece
GC: Manolis A. Christodoulou
PC: Manolis A. Christodoulou, Petros Ioannou
Plenaries: George N. Saridis, H. E. Rauch

Legend: GC: general chair(s) and co-chair(s). PC: program chair(s) and co-chair(s). HC: Honorary chair(s). For details, visit https://www.med-control.org/main/conferences/.

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MESSAGE FROM THE MCA PRESIDENT

Welcome! On behalf of MCA (www.med-control.org), the parent organization of the MED conferences, I would like to welcome you to the 2023 MED, the 31st^{h} Mediterranean Conference on Control and Automation, taking place in Limassol, Cyprus. Thank you for your participation and contributions; they are absolutely essential in making MED a success. As a reminder, the MED Conference Proceedings may be found on line at http://ieeexplore.ieee.org. The Proceedings of early MED Conferences may be downloaded from www.med-control.org, where you may also find Book of Abstracts as well as conference reports of previous MED that have appeared in the IEEE Control Systems Magazine.

I will take this opportunity to share some thoughts with you regarding our field and what I think is a good way to address important and urgent problems and move forward:

Learning how to learn: We are here because we care about Control Systems. In Control we strive to make systems achieve desirable objectives, goals, in spite of uncertainties in the plant and its environment. We rely heavily on mathematical models and methods to accomplish this. However, let's not forget that although we enjoy math subtleties and elegant proofs, math is the means and not the goal. The objective is autonomy in achieving goals under uncertainties. For high levels of autonomy, we need methods beyond those that are based on ODEs with constant coefficients. Are we using effectively and efficiently advances from other fields? We have added Machine Learning (ML) to our lists of tools we can use; in fact, ML was close to control in the 1970s, it was rediscovered in the 1990s and the success of neural networks in deep learning triggered a lot of interest in ML for control rather recently. The question is whether we have set up the problem correctly or are we trying to use ML on everything hoping for the best? Have we formulated the on-line learning control problem appropriately so to use the right ML methods? We should be able to learn new control laws on-line from a small set of meaningful data that apply directly to our case, not from mountains of data hoping that something in there is relevant to our case; that approach could be perhaps appropriate for off-line control learning. We may need to obtain the targeted data via active experimentation, like humans do. And of course, the new learned controller has to be correct the first time and every time! Only then on-line learning control will be used in critical applications. The point is that we need to decide what we are looking for to enhance autonomy, we need to define our problem appropriately and then modify and adapt methods from other fields to meet our specific needs. We need to modify methodologies to solve our problems, not the other way around. This is the way forward.

Enjoy the MED'23 conference! Looking ahead, MED'24 goes to Crete, Greece and I am looking forward to seeing you all there!

Panos Antsaklis, University of Notre Dame

President, Mediterranean Control Association

WELCOME MESSAGE FROM THE GENERAL CHAIR

Dear MED2023 Participants:

I am very excited to welcome you at the 31st Mediterranean Conference on Control and Automation set to take place in the cosmopolitan city of Limassol, Cyprus. The venue for the conference is the GrandResort, a 5-star hotel, situated on a beautiful beachfront, near the ancient "Amathounta", approximately 11 km from the Limassol City Center. This is the fourth time that the conference is organized in Cyprus. Previous times were in Limassol in 1995, in Paphos in 1997, and again in Limassol in 2005.

We have put together an excellent technical program featuring three world renowned and young excellent plenary speakers, technical sessions in many areas of automatic control, robotics, and machine learning, as well as applications in smart grids and transportation. I would like to thank all of you and your co-authors for submitting your cutting-edge research to the conference. Of course, a special thank you is deserved to the Program Chair and Vice-Chair for the excellent and timely job they have done coordinating the reviewing process and putting together a top-quality technical program. Special thanks also go to all Associated Editors and reviewers for all their effort in maintaining the high standard of our conference.

Beyond the technical program, we have included social events for your entertainment. The welcoming reception will be held on Monday evening at the venue hotel offering us the first opportunity to meet and enjoy some drinks and snacks overlooking the Mediterranean Sea. On Wednesday, we will have the banquet dinner at the Dafermou Winery which is located outside of the traditional village of Lefkara. Sessions on Wednesday will end earlier so can visit Lefkara which is located at the foot of Troodos Mountains, at an altitude of around 650m, about a 40-minute ride away from the GrandResort. During the visit, we will have the opportunity to walk around the narrow streets of the village before we reach the restaurant, so I suggest you wear your comfortable shoes and since we will be at an altitude, a light sweater may be needed.

Limassol is a modern city with rich history. During your stay, you may want to enjoy a walk in the old city, near the Limassol Castle, or visit the Limassol Marina or even get outside the city and visit the Kolossi Castle or the Kourion Archeological site. If you need any suggestions about places to visit, don't hesitate to ask us at the conference registration desk.

Closing, I would like to express my sincere gratitude to all the members of the Organizing Committee and volunteers for their hard work and for making the conference a reality. I hope you will enjoy the conference and have a memorable experience during your stay in Cyprus.

With my best regards,

Christos Panayiotou

General Chair

WELCOME MESSAGE FROM THE PROGRAM CHAIRS

On behalf of the International Program Committee and the Local Organizing Committee of the 31st Mediterranean Conference on Control and Automation (MED2023), we welcome the participants of the conference to be held in Limassol (Cyprus) on June 26-29, 2023.

The conference is organised by KIOS and the University of Cyprus. It is technically cosponsored by the IEEE Control System Society, the IEEE Robotics and Automation Society, and the International Conference on Unmanned Aircraft Systems Association (ICUAS).

Following the great success of and acceptance by the international community of control, *MED Conferences* are organized every year since 1993. *Previous MED Conferences* demonstrated the demand for establishing a continuous scientific forum in the fields of intelligent systems, control, automation, communication, optimization and robotics.

The program of MED2023 includes 26 regular and 4 invited sessions in 5 parallel tracks. Moreover, the program contains 3 plenary talks prepared by outstanding academic experts. We hope that those talks will give the participants the opportunity to share in the knowledge and experience of world-renowned scientists and experts in many exciting topics such as automated vehicles, prediction, optimization and control of complex systems and resilient robotic systems. The program also includes 5 workshops and 1 tutorial session.

We hope that you will find your participation in MED2023 very stimulating and rewarding. Moreover, we believe that a few days' stay in Limassol and other parts of Cyprus will give you an opportunity to enjoy and to learn more about the country and the local culture.

We would like to thank all members of the International Program Committee for their excellent work revising more than 230 submissions in ensuring a high quality of the conference program.

Special thanks go to the members of the Local Organizing Committee for their hard work that made it possible to organize this international scientific event.

We wish all participants to enjoy the 31st Mediterranean Conference on Control and Automation (MED2023), and a pleasant stay in Limassol and Cyprus.

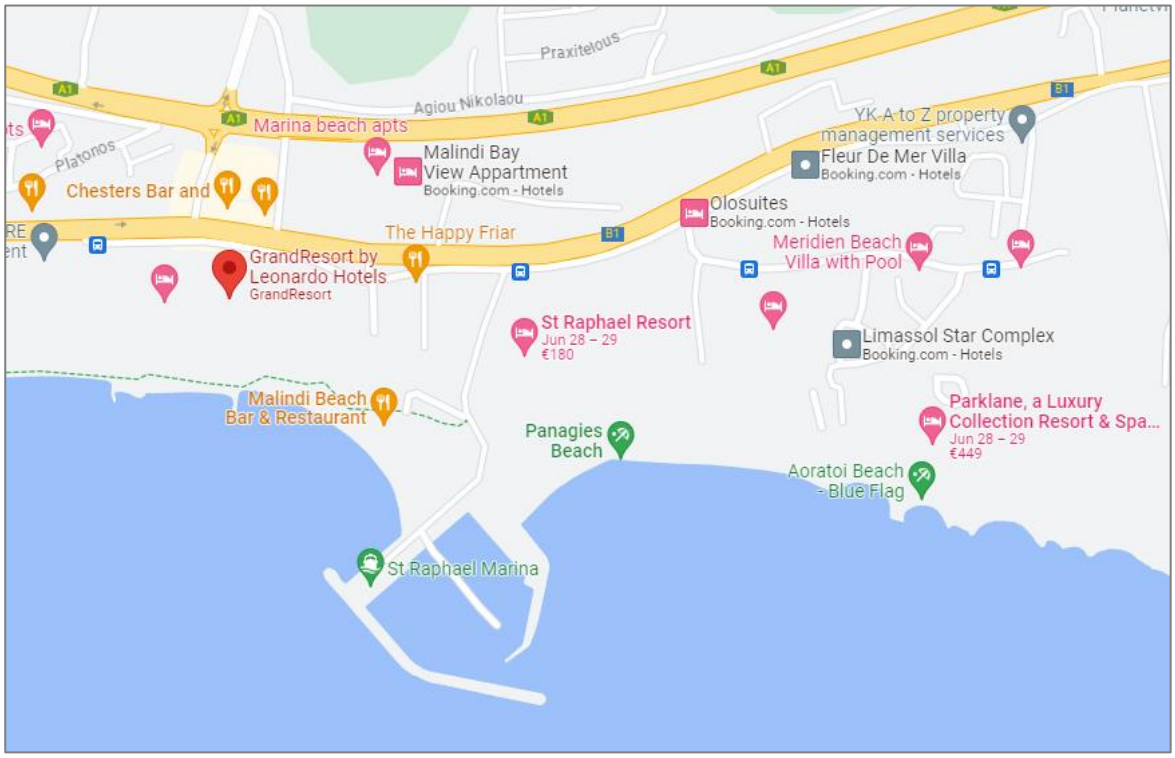
Vicenç Puig and Marcin Witczak,

Program Chairs

MED2023 INFORMATION

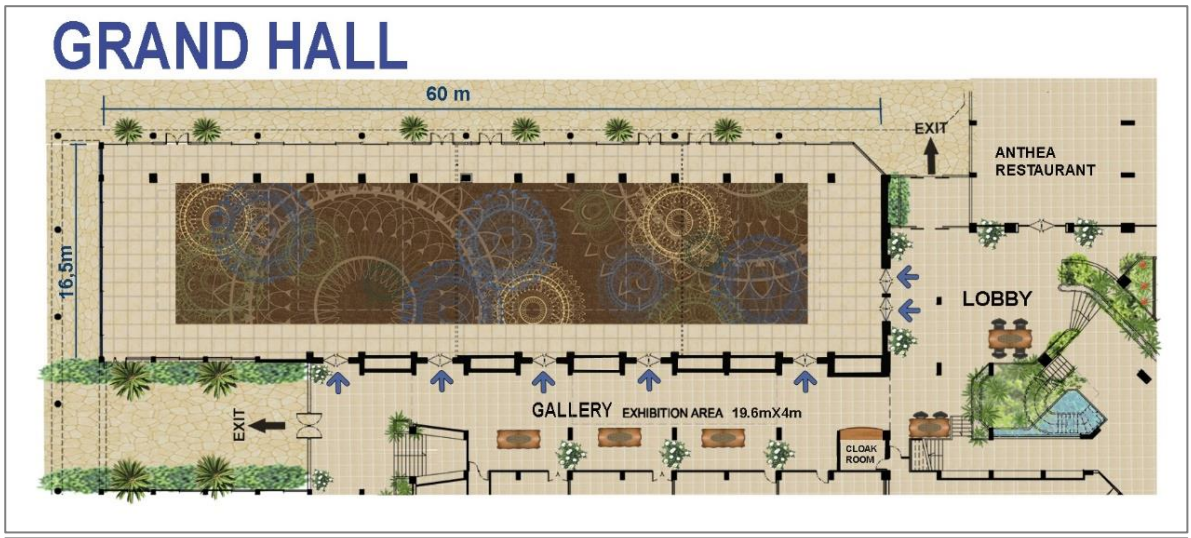
The Venue

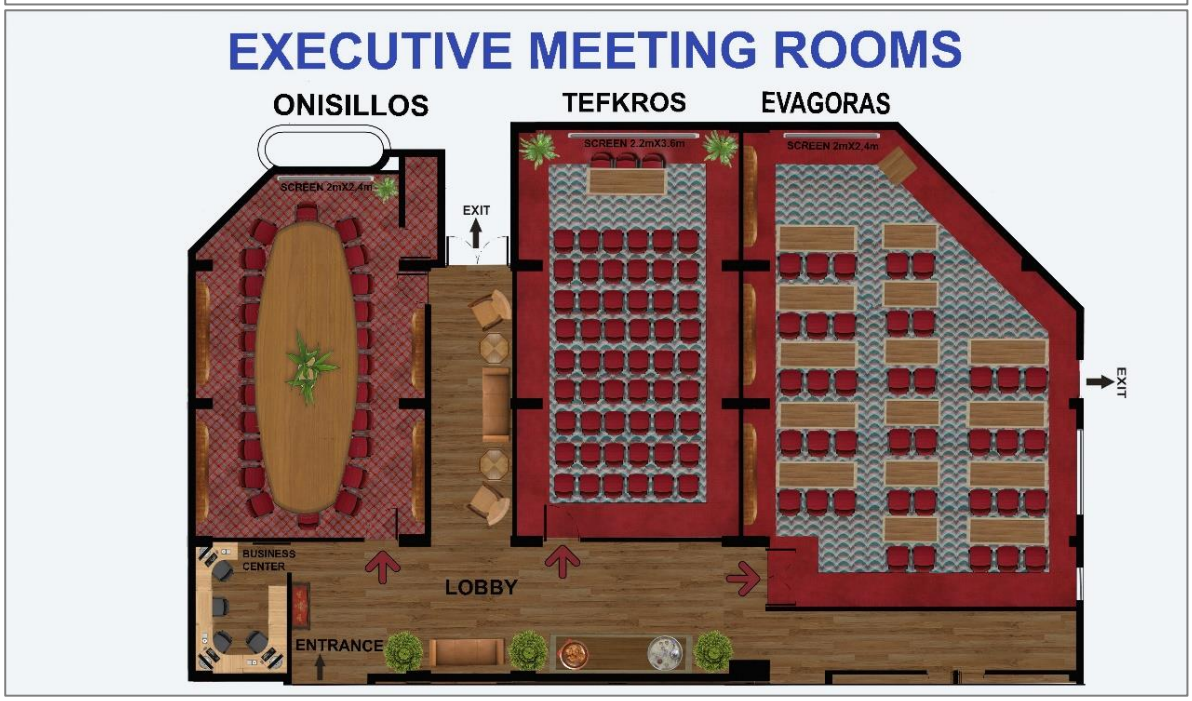
The Conference will take place in Limassol, Cyprus. The venue is the five-star GrandResort Hotel, located on a superb beachside location, 11km from Limassol town center. For more information about the venue and the surrounding area visit the website:
https://www.grandresort.com.cy/



General Information

The conference sessions and workshops will take place in *Grand Hall A*, *Grand Hall B*, and *Grand Hall C* as well as in the Executive Rooms *Tefkros* and *Evagoras*. Registration will be in *Grand Hall A*.





Conference Technical Sessions – Tuesday, June 27 – Thursday, June 29

There are five parallel technical sessions each day. All conference sessions, including Workshops, will be in *Grand Hall A*, *Grand Hall B*, and *Grand Hall C*, and in Executive Rooms *Tefkros* and *Evagoras*.

Conference Registration

Registration (either physical or hybrid) is mandatory for all conference participants, authors, and non-authors. Registration fees are in Euros (€).

- Regular registration includes access to all technical sessions, 1 paper upload, coffee breaks, banquet, and receptions. It also includes a copy of the conference proceedings.
- Student registration includes access to all technical sessions, coffee breaks, banquet, and receptions. It also includes a copy of the conference proceedings.
- Workshops registration includes access to workshop sessions and coffee breaks.

REGISTRATION INFORMATION					
Conference Registration	**Advance/Early (by May 20)**	**Late/Onsite (after May 20)**	**Paper uploads**	**Additional paper upload**	**Lunches/Coffee Breaks & Banquet**
Standard	€575	€675	1	€275	Included
Student/Retiree	€300	€350	N/A	N/A	Included
Additional page charge		**Additional banquet ticket**		**Workshops Registration**	
€120 per page		€110		€100	

For registration visit the website:
https://www.eventora.com/en/Events/31st-mediterranean-conference-

The registration desk will be open during the following hours:
Monday, June 26: 16:00 – 19:00
Tuesday, June 27: 08:00 – 18:00
Wednesday, June 28: 08:00 – 18:00
Thursday, June 29: 08:00 – 18:00

Mobile App

The conference program as well as the paper abstracts can be accessed by the participants through the MED 2023 mobile app. The app provides additional functionalities for personalization, communication, and push notifications for any updates to enhance your experience. The app is available on Android, iOS, and Windows and can be downloaded from http://conference4me.eu/download/
When you open the app, search for 'MED' to load the MED 2023 conference mobile agenda.

Internet Access

All registered attendees will have complementary internet access.

Coffee breaks

There will be two coffee breaks and one lunch break each day, a Welcome Reception, as well as a Banquet Dinner for all registered participants.

Social Program

The MED2023 social agenda includes the Welcome Reception at the Conference Venue (GrandResort) on Monday, June 26, at 7:30 pm, and a Banquet Dinner at the beautiful village of Lefkara, on Wednesday, June 28.

Travelling to Limassol

The city of Limassol is easily reached by land and air. Visitors arriving by air, may enter the Republic of Cyprus only through the International Airports of Larnaca and Paphos. Entry via any other airport is illegal (Visitcyprus.com).

The driving distance from Larnaca and Paphos International Airports to the Conference Venue in Limassol is 54 km (40' drive) and 73 km (50' drive) respectively. Visitors can reach the city of Limassol by bus or taxi. For more information you can visit:
https://kapnosairportshuttle.com/
http://enlimassolairportexpress.eu/
https://www.hermesairports.com/prepare-your-journey/fly-in/public-transportation

PLENARY LECTURES

The 31st Mediterranean Conference on Control and Automation includes three Keynote Lectures given by leading authorities in their respective fields. All Plenary Lectures will take place in the Grand Hall. The Plenary Lectures schedule is shown below.

PLENARY LECTURES		
Day	**Time**	**Details**
Tuesday June 27	08:50-10:00	**Traffic Control Using Automated Vehicles: Distributed Sensing, Actuation, and Learning** Prof. *Karl H. Johansson*, KTH Royal Institute of Technology
Wednesday June 28	08:50-10:00	**Bridging the Gap in Prediction, Optimization, and Control of Integrated Dynamic Systems** Prof. *Jing Sun*, University of Michigan
Thursday June 29	08:50-10:00	**Resilient Robotic Autonomy: Methods and Systems** Prof. *Kostas Alexis*, Norwegian University of Science and Technology (NTNU)

WORKSHOPS / TUTORIALS

MED2023 offers five Workshops and one Tutorial Session that will take place on Thursday, June 29.

- **Workshop ThWS11: 14:00-18:30**
  Workshop on Adaptive Control to Intelligent Transportation Systems in Celebration of Prof. Petros Ioannou's 70th Birthday

- **Workshop ThWS12: 14:00-18:30**
  Indoor Environmental Quality (IEQ) Monitoring and Control for Smart Buildings

- **Workshop ThWS13: 14:00-18:30**
  Cybersecurity for Electrical Power and Energy Systems

- **Workshop ThWS14: 14:00-18:30**
  STC 4.0 HP – New Generation of Stoneware Tableware in Ceramic 4.0 by High Pressure Casting Robot Work Cell

- **Workshop ThWS15: 14:00-18:30**
  Workshop on Control and Cybersecurity in Connected and Autonomous Vehicles

- **Tutorial Session ThAT1: 10:30-12:30**
  A Review of Wireless Positioning Techniques and Technologies: From Smart Sensors to 6G

PROGRAM AT A GLANCE

Technical Program Tuesday June 27, 2023

Track 1	Track 2	Track 3	Track 4	Track 5
08:50-10:00 Grand Hall Plenary Session TuPP Traffic Control Using Automated Vehicles: Distributed Sensing, Actuation, and Learning (Prof. Karl H. Johansson)				
10:30-12:30 Grand Hall A Regular Session TuA1 Unmanned Systems	10:30-12:30 Grand Hall B Regular Session TuA2 Fault Diagnosis	10:30-12:30 Grand Hall C Regular Session TuA3 Energy Management and Sustainability	10:30-12:30 Tefkros Regular Session TuA4 Autonomous Vehicles (I)	10:30-12:30 Evagoras Regular Session TuA5 Image Processing
14:00-16:00 Grand Hall A Regular Session TuB1 Autonomous Systems	14:00-16:00 Grand Hall B Regular Session TuB2 Fault Tolerant Control	14:00-16:00 Grand Hall C Regular Session TuB3 Power Systems and Smart Grid	14:00-16:00 Tefkros Regular Session TuB4 Autonomous Vehicles (II)	14:00-16:00 Evagoras Invited Session TuB5 Intelligent Data Processing in Control and Decision Support Systems (SENSYS 23)
16:30-18:50 Grand Hall A Regular Session TuC1 Navigation	16:30-18:50 Grand Hall B Regular Session TuC2 Cyber-Physical Systems	16:30-18:50 Grand Hall C Regular Session TuC3 Automotive Control	16:30-18:50 Tefkros Invited Session TuC4 Developing an Ubiquitous Automation and Control Paradigm for Congested Transportation Systems	16:30-18:50 Evagoras Invited Session TuC5 Intelligent Systems and Learning Methods in Control and Decision Support Systems

MED 2023 Technical Program Wednesday June 28, 2023

Track 1	Track 2	Track 3	Track 4	Track 5
08:50-10:00 Grand Hall Plenary Session WePP Bridging the Gap in Prediction, Optimization, and Control of Integrated Dynamic Systems (Prof. Jing Sun)				
10:30-12:30 Grand Hall A Regular Session WeA1 Robotics (I)	10:30-12:30 Grand Hall B Regular Session WeA2 Computational Intelligence	10:30-12:30 Grand Hall C Regular Session WeA3 Nonlinear Control (I)	10:30-12:30 Tefkros Regular Session WeA4 Robust Control and Estimation	10:30-12:30 Evagoras Regular Session WeA5 Distributed Systems
14:00-16:00 Grand Hall A Regular Session WeB1 Robotics (II)	14:00-16:00 Grand Hall B Regular Session WeB2 Intelligent Control Systems	14:00-16:00 Grand Hall C Regular Session WeB3 Nonlinear Control (II)	14:00-16:00 Tefkros Regular Session WeB4 Linear Systems	14:00-16:00 Evagoras Regular Session WeB5 Multi-Agent Systems

MED 2023 Technical Program Thursday June 29, 2023

Track 1	Track 2	Track 3	Track 4	Track 5	Track T1
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10:30-12:30 Grand Hall A Regular Session ThA1 Adaptive Control	10:30-12:30 Grand Hall B Regular Session ThA2 Predictive Control	10:30-12:30 Grand Hall C Regular Session ThA3 Industrial Automation and Manufacturing	10:30-12:30 Tefkros Invited Session ThA4 Analytical Methods for Control Design and Qualitative Study of Complex Dynamical Systems	10:30-12:30 Evagoras Regular Session ThA5 Biomedical Engineering	10:30-12:30 Onisillos Tutorial Session ThAT1 A Review of Wireless Positioning Techniques and Technologies: From Smart Sensors to 6G
14:00-16:00 Grand Hall A Workshop ThWS11 Workshop on Adaptive Control to Intelligent Transportation Systems in Celebration of Prof. Petros Ioannou's 70th Birthday (I)	14:00-16:00 Grand Hall B Workshop ThWS12 Indoor Environmental Quality (IEQ) Monitoring and Control for Smart Buildings (I)	14:00-16:00 Grand Hall C Workshop ThWS13 Cybersecurity for Electrical Power and Energy Systems (I)	14:00-16:00 Tefkros Workshop ThWS14 STC 4.0 HP – New Generation of Stoneware Tableware in Ceramic 4.0 by High Pressure Casting Robot Work Cell (I)	14:00-16:00 Evagoras Workshop ThWS15 Workshop on Control and Cybersecurity in Connected and Autonomous Vehicles (I)	
16:30-18:30 Grand Hall A Workshop ThWS21 Workshop on Adaptive Control to Intelligent Transportation Systems in Celebration of Prof. Petros Ioannou's 70th Birthday (II)	16:30-18:30 Grand Hall B Workshop ThWS22 Indoor Environmental Quality (IEQ) Monitoring and Control for Smart Buildings (II)	16:30-18:30 Grand Hall C Workshop ThWS23 Cybersecurity for Electrical Power and Energy Systems (II)	16:30-18:30 Tefkros ThWS24 STC 4.0 HP – New Generation of Stoneware Tableware in Ceramic 4.0 by High Pressure Casting Robot Work Cell (II)	16:30-18:30 Evagoras Workshop ThWS25 Workshop on Control and Cybersecurity in Connected and Autonomous Vehicles (II)	

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Makni, Salama	University of Picardy Jules Verne
El Hajjaji, Ahmed	University of Picardy Jules Verne
Chaabane, Mohamed	National Engineering School of Sfax, Tunisia

11:50-12:10 TuA2.5

Dynamic Modelling for Non-Stationary Bearing Vibration Signals, pp. 55-60.

Galli, Federica	IRSEEM/ESIGELEC
Sircoulomb, Vincent	IRSEEM/ESIGELEC
Fiore, Giuseppe	CNES
Hoblos, Ghaleb	IRSEEM/ESIGELEC
Weber, Philippe	University of Lorraine

12:10-12:30 TuA2.6

Unsupervised Anomaly Detection for Multivariate Incomplete Data Using GAN-Based Data Imputation: A Comparative Study, pp. 61-68.

Sarda, Kisan	University of Sannio
Yerudkar, Amol	Zhejiang Normal University
Del Vecchio, Carmen	University of Sannio

TuA3 Grand Hall C

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Chair: Leva, Alberto	Politecnico Di Milano
Co-Chair: Eliades, Demetrios	University of Cyprus

10:30-10:50 TuA3.1

Stochastic Thermodynamics: Dissipativity, Losslessness, Accumulativity, Energy Storage, and Entropy Production, pp. 69-74.

Lanchares, Manuel	Georgia Institute of Technology
Haddad, Wassim M.	Georgia Institute of Technology

10:50-11:10 TuA3.2

Efficient Control-Oriented Modelling of Heterogeneous Large-Scale Computer Cooling Systems, pp. 75-80.

Leva, Alberto	Politecnico Di Milano
Terraneo, Federico	Politecnico Di Milano
Fornaciari, William	Politecnico Di Milano

11:10-11:30 TuA3.3

An Interlaced Co-Estimation Technique for Batteries, pp. 81-86.

Mostacciuolo, Elisa	University of Sannio
Iannelli, Luigi	University of Sannio
Baccari, Silvio	University of Campania
Vasca, Francesco	University of Sannio

11:30-11:50 TuA3.4

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Kouzapas, Dimitrios	University of Cyprus
Stylianidis, Nearchos	University of Cyprus
Panayiotou, Christos	University of Cyprus
Eliades, Demetrios	University of Cyprus

11:50-12:10 TuA3.5

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Kavga, Angeliki	University of Patras
Thomopoulos, Vasileios	University of Patras
Petrakis, Theodoros	University of Patras

12:10-12:30 TuA3.6

Nonlinear MPC for Fuel Cell Air Path Control with Experimental Validation, pp. 97-102.

Schmitt, Lukas	RWTH Aachen University
Abel, Dirk	RWTH Aachen University

TuA4 Tefkros

Autonomous Vehicles (I) (Regular Session)

Chair: Votis, Konstantinos	Center for Research and Technology - Hellas
Co-Chair: Tsourveloudis, Nikos	Technical University of Crete

10:30-10:50 TuA4.1

Bibliometric Analysis on Applications of Digital Twins in Autonomous Vehicles, pp. 103-108.

Sarantinoudis, Nikolaos	Technical University of Crete
Tsinarakis, George	Technical University of Crete
Doitsidis, Lefteris	Technical University of Crete
Tsourveloudis, Nikos	Technical University of Crete
Arampatzis, George	Technical University of Crete

10:50-11:10 TuA4.2

EVENT: Real Time Video Feed Anomaly Detection for Enhanced Security in Autonomous Vehicles, pp. 109-114.

Aivatoglou, Georgios	Center for Research and Technology - Hellas
Oikonomou, Nikolaos	Center for Research and Technology - Hellas
Spanos, Georgios	Center for Research and Technology - Hellas
Livitckaia, Kristina	Center for Research and Technology - Hellas
Votis, Konstantinos	Center for Research and Technology - Hellas
Tzovaras, Dimitrios	Center for Research and Technology - Hellas

11:10-11:30 TuA4.3

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Anagnostopoulos, Christos	Industrial Systems Institute / Athena Research Center
Lalos, Aris	Athena Research Center
Stylios, Chrysostomos	Athena Research Center
Petros Kapsalas, Petros	Panasonic Automotive Systems Europe
Nguyen, Duong-Van	Panasonic Automotive Systems Europe

11:30-11:50 TuA4.4

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Bel Haj Frej, Ghazi	University of Bordeaux
Moreau, Xavier	University of Bordeaux
Guridis, Ramon	STELLANTIS
Benine-Neto, André	University of Bordeaux
Hernette, Vincent	Groupe PSA

11:50-12:10 TuA4.5

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Sersemis, Athanasios	Center for Research and Technology - Hellas
Alexandros, Papadopoulos	Center for Research and Technology - Hellas
Spanos, Georgios	Center for Research and Technology - Hellas
Lalas, Antonios	Center for Research and Technology - Hellas
Votis, Konstantinos	Center for Research and Technology - Hellas
Tzovaras, Dimitrios	Center for Research and Technology - Hellas

TuA5 Evagoras

Image Processing (Regular Session)

Chair: Gasparri, Andrea	Università Degli Studi Roma Tre
Co-Chair: Itami, Taku	Aoyamagakuin University

10:30-10:50 TuA5.1

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Mitsuhashi, Hayato	Aoyama Gakuin University
Akamine, Souta	Aoyama Gakuin University
Itami, Taku	Aoyama Gakuin University
Yoneyama, Jun	Aoyama Gakuin University

10:50-11:10 TuA5.2

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Arlotta, Andrea	Roma Tre University
Lippi, Martina	Roma Tre University
Gasparri, Andrea	Roma Tre University

11:10-11:30	TuA5.3
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Ye, Jianlin	University of Central Lancashire Cyprus Campus
Ioannou, Stelios	University of Central Lancashire Cyprus Campus
Nikolaou, Panagiota	University of Central Lancashire Cyprus Campus
Raspopoulos, Marios	University of Central Lancashire Cyprus Campus
11:30-11:50	TuA5.4
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Abdulsalam, Mahmoud	City, University of London
Chekakta, Zakaria	City, University of London
Aouf, Nabil	City, University of London
Hogan, Maxwell	City, University of London
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Athni Hiremath, Sandesh	Rhineland-Palatinate Technical University Kaiserslautern-Landau
Gummadi, Praveen	Rhineland-Palatinate Technical University Kaiserslautern-Landau
Bajcinca, Naim	Rhineland-Palatinate Technical University Kaiserslautern-Landau

TuB1	Grand Hall A
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Chair: Kyriakopoulos, Kostas J.	National Tech. Univ. of Athens
Co-Chair: Wickers, Aaron	Helmut Schmidt Universität / University of the Federal Armed Forces Hamburg
14:00-14:20	TuB1.1
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Panetsos, Fotis	National Technical University of Athens
Karras, George	University of Thessaly
Kyriakopoulos, Kostas J.	National Technical University of Athens
Oikonomides, Odysseas	University of Cyprus
Kolios, Panayiotis	University of Cyprus
Eliades, Demetrios	University of Cyprus
Panayiotou, Christos	University of Cyprus
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Zacharia, Angelos	University of Cyprus
Papaioannou, Savvas	University of Cyprus
Kolios, Panayiotis	University of Cyprus
Panayiotou, Christos	University of Cyprus
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Hadjiloizou, Loizos	KTH Royal Institute of Technology
Makridis, Evagoras	University of Cyprus
Charalambous, Themistoklis	University of Cyprus
Deliparaschos, Kyriakos	Cranfield University
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Papaioannou, Savvas	University of Cyprus
Laoudias, Christos	University of Cyprus
Kolios, Panayiotis	University of Cyprus
Theocharides, Theocharis	University of Cyprus
Panayiotou, Christos	University of Cyprus
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Bjerkeng, Magnus	SINTEF Digital
Grøtli, Esten Ingar	SINTEF Digital
Kirkhus, Trine	Sintef Digital
Jens, Thielemann	Sintef Digital

Amundsen, Herman Biørn	Norwegian University of Science and Technology
Su, Biao	SINTEF Ocean
Ohrem, Sveinung Johan	SINTEF Ocean

15:40-16:00 TuB1.6

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Wickers, Aaron	Helmut Schmidt University
Schulzke, Alexander	Helmut Schmidt University
Myschik, Stephan	University of the Bundeswehr Munich
Alpen, Mirco	Helmut Schmidt University
Horn, Joachim	Helmut Schmidt University

TuB2 Grand Hall B

Fault Tolerant Control (Regular Session)

Chair: Witczak, Marcin	University of Zielona Gora
Co-Chair: Henry, David	Universite Bordeaux

14:00-14:20 TuB2.1

Optimal Trajectory Generation for Recovery of Quad-Plane UAVs with Complete Rotor Loss in Hover Flight, pp. 204-209.

Strampe, Tilman	Technical University Darmstadt

14:20-14:40 TuB2.2

An Output-Feedback Fault-Tolerant Control Approach for Multiple Faults, pp. 210-215.

Pazera, Marcin	University of Zielona Gora
Witczak, Marcin	University of Zielona Gora
Puig, Vicenç	Universitat Politècnica De Catalunya (UPC)
Aubrun, Christophe	University of Lorraine

14:40-15:00 TuB2.3

Fault Tolerant Control Using Sliding Modes for Scale Model of a High Altitude Long Endurance Aircraft, pp. 216-221.

Rawikara, Seno Sahisnu	University of Exeter
Alwi, Halim	University of Exeter
Edwards, Christopher	University of Exeter

15:00-15:20 TuB2.4

An Integral--Based Control Allocation Algorithm for Optimal Spacecraft Actuator Selection under L1, L2, Linfinity Criteria for Fault Tolerance, pp. 222-228.

Henry, David	University of Bordeaux

15:20-15:40 TuB2.5

Fault Tolerant Control of Hexarotor UAVs against Motor Failure, pp. 229-234.

Liao, Fang	National University of Singapore
Zhao, Zuoquan	The Chinese University of Hong Kong
Wang, Jianliang	Hangzhou Innovation Institute of Beihang University

15:40-16:00 TuB2.6

Adaptive Backstepping Sliding Mode Based Fault-Tolerant Cooperative Control for Multiple UAVs under Thrust Loss Faults and Input Saturation, pp. 235-240.

Yang, Zhongyu	Nanjing University of Aeronautics and Astronautics
Yu, Ziquan	Nanjing University of Aeronautics and Astronautics
Cheng, Yuehua	Nanjing University of Aeronautics and Astronautics
Xu, Guili	Nanjing University of Aeronautics and Astronautics
Zhang, Youmin	Concordia University

TuB3 Grand Hall C

Power Systems and Smart Grid (Regular Session)

Chair: Boem, Francesca	University College London
Co-Chair: Konstantopoulos, George	University of Patras

14:00-14:20 TuB3.1

Resilient Distributed Integral Control for Multimachine Power Systems with Inherent Input Constraint Satisfaction, pp. 241-246.

Kavvathas, Theodoros	University of Patras
Konstantopoulos, George	University of Patras
Konstantinou, Charalambos	King Abdullah University of Science and Technology (KAUST)

14:20-14:40 TuB3.2

Control of Isolated AC Microgrids with Constant Power Loads: A Set Invariance Approach, pp. 247-252.

Michos, Grigoris — University of Sheffield
Konstantopoulos, George — University of Patras
Trodden, Paul — University of Sheffield
Kadirkamanathan, Visakan — University of Sheffield

14:40-15:00 TuB3.3

Position and Speed Observer for PMSM with Unknown Stator Resistance and Inductance, pp. 253-258.

Matveev, Kirill — ITMO University
Bazylev, Dmitry — ITMO University
Dobriborsci, Dmitrii — Deggendorf Institute of Technology

15:00-15:20 TuB3.4

DFIG Wind Turbine Novel Cascade Control Guaranteeing Sensorless Field Orientation and Stability, pp. 259-264.

Papageorgiou, Panos — University of Patras
Bourdoulis, Michael — University of Patras
Alexandridis, Antonio — University of Patras

15:20-15:40 TuB3.5

An Event-Triggered Dynamic Consensus-Based Adaptive Electric Vehicles Fast Charging Control in an Isolated Microgrid, pp. 265-270.

Abdelhamid, Mohamed — Alexandria University
Abbasy, Nabil — Alexandria University
Abuelanien, Ahmed — Alexandria University

15:40-16:00 TuB3.6

An Online Learning Method for Microgrid Energy Management Control, pp. 271-276.

Casagrande, Vittorio — University College London
Ferianc, Martin — University College London
Rodrigues, Miguel — University College London
Boem, Francesca — University College London

TuB4 Tefkros

Autonomous Vehicles (II) (Regular Session)

Chair: Gasparri, Andrea — Università Degli Studi Roma Tre
Co-Chair: Alma, Marouane — CRAN, Université De Lorraine

14:00-14:20 TuB4.1

MSL3D: Pointcloud-Based Muck Pile Segmentation and Localization in Unknown SubT Environments, pp. 277-282.

Valdes Saucedo, Mario Alberto — Luleå University of Technology
Kanellakis, Christoforos — Luleå University of Technology
Nikolakopoulos, George — Luleå University of Technology

14:20-14:40 TuB4.2

A Swarm-Based Distributed Algorithm for Target Encirclement with Application to Monitoring Tasks in Precision Agriculture Scenarios, pp. 283-288.

de Carolis, Giovanni — Roma Tre University
Williams, Ryan — Virginia Polytechnic Institute and State University
Gasparri, Andrea — Roma Tre University

14:40-15:00 TuB4.3

A Novel High-Interaction Honeypot Network for Internet of Vehicles, pp. 289-294.

Anastasiadis, Mike — Centre for Research and Technology - Hellas
Moschou, Konstantinos — Centre for Research and Technology - Hellas
Livitckaia, Kristina — Centre for Research and Technology - Hellas
Votis, Konstantinos — Centre for Research and Technology - Hellas
Tzovaras, Dimitrios — Centre for Research and Technology - Hellas

15:00-15:20 TuB4.4

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Theodosis, Dionysios — Technical University of Crete
Karafyllis, Iasson — National Technical University of Athens
Titakis, George — Technical University of Crete
Papamichail, Ioannis — Technical University of Crete

Papageorgiou, Markos	Technical University of Crete

15:20-15:40 TuB4.5

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Mohite, Shivaraj	University of Lorraine
Alma, Marouane	University of Lorraine
Zemouche, Ali	University of Lorraine
Haddad, Madjid	SEGULA TECHNOLOGIES

15:40-16:00 TuB4.6

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Ferreira, Anna Rafaela Silva	Pontifical Catholic University of Rio De Janeiro
Medeiros, Vivian Suzano	University of São Paulo
Hultmann Ayala, Helon Vicente	Pontifical Catholic University of Rio De Janeiro
Meggiolaro, Marco Antonio	Pontifical Catholic University of Rio De Janeiro

TuB5 Evagoras

Intelligent Data Processing in Control and Decision Support Systems (SENSYS 23) (Invited Session)

Chair: Popescu, Dan	University POLITEHNICA of Bucharest
Co-Chair: Ichim, Loretta	Politehnica University of Bucharest
Organizer: Popescu, Dan	University POLITEHNICA of Bucharest
Organizer: Lazar, Corneliu	Gheorghe Asachi Technical University of Iasi
Organizer: Ichim, Loretta	Politehnica University of Bucharest

14:00-14:20 TuB5.1

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Popescu, Andreea Bianca	Transilvania University of Brasov
Nita, Cosmin	Transilvania University of Brasov
Taca, Ioana Antonia	Transilvania University of Brasov
Vizitiu, Anamaria	Transilvania University of Brasov
Itu, Lucian	Transilvania University of Brasov

14:20-14:40 TuB5.2

Deep Convolutional Neural Networks for Real-Time Human Detection and Tracking on UAVs Embedded Systems (I), pp. 319-324.

Serghei, Trandafir-Liviu	Polytechnic University of Bucharest
P rvu, Petrisor	Polytechnic University of Bucharest
Simon, Madalina-Oana	Polytechnic University of Bucharest
Popescu, Dan	Polytechnic University of Bucharest
Ichim, Loretta	Polytechnic University of Bucharest

14:40-15:00 TuB5.3

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Dinca, Alexandru	Polytechnic University of Bucharest
Angelescu, Nicoleta	Valahia University of Targoviste
Ichim, Loretta	Polytechnic University of Bucharest
Popescu, Dan	Polytechnic University of Bucharest

15:00-15:20 TuB5.4

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Stan, Anrei-Stelian	Polytechnic University of Bucharest
Ichim, Loretta	Polytechnic University of Bucharest
P rvu, Petrisor	Polytechnic University of Bucharest
Popescu, Dan	Polytechnic University of Bucharest

15:20-15:40 TuB5.5

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Baciu, Andrei	Gheorghe Asachi Technical University of Iasi
Lazar, Corneliu	Gheorghe Asachi Technical University of Iasi

15:40-16:00 TuB5.6

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Stanescu, Cristian	Valahia University of Targoviste
Predusca, Gabriel	University Valahia of Targoviste
Angelescu, Nicoleta	Valahia University of Targoviste

Circiumarescu, Denisa	University Valahia of Targoviste
Puchianu, Dan Constantin	Valahia University of Targoviste
Hagiescu, Daniela	Advanced Slisys SRL

TuC1	Grand Hall A
Navigation (Regular Session)	
Chair: Tzes, Anthony	New York University Abu Dhabi
Co-Chair: Khorrami, Farshad	NYU Tandon School of Engineering (polytechnic Institute)

16:30-16:50 TuC1.1

Precise Orbit Determination on LEO Satellite Using Pseudorange and Pseudorange-Rate Measurements, pp. 349-355.

Tantucci, Andrea	Sapienza University of Rome
Wrona, Andrea	Sapienza University of Rome
Pietrabissa, Antonio	Consortium for the Research in Automation and Telecommunication

16:50-17:10 TuC1.2

Spline-Based Dynamic Object Handling in Autonomous Vehicles: A Model-Based Path Planning Algorithm, pp. 356-363.

Stefanopoulou, Aliki	Democritus University of Thrace
Gkelios, Socratis	Democritus University of Thrace
Kapoutsis, Athanasios	Centre for Research and Technology - Hellas
Kosmatopoulos, Elias	Democritus University of Thrace
Boutalis, Yiannis	Democritus University of Thrace

17:10-17:30 TuC1.3

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Skaldebø, Martin	SINTEF Ocean
Ohrem, Sveinung Johan	SINTEF Ocean
Kelasidi, Eleni	SINTEF Ocean
Amundsen, Herman Biørn	Norwegian University of Science and Technology
Bloecher, Nina	SINTEF Ocean

17:30-17:50 TuC1.4

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Stamatopoulos, Marios-Nektarios	Luleå University of Technology
Koustoumpardis, Panagiotis	University of Patras
Seisa, Achilleas Santi	Luleå University of Technology
Nikolakopoulos, George	Luleå University of Technology

17:50-18:10 TuC1.5

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Inan, Burak Alp	City, University of London
Rondao, Duarte	City, University of London
Aouf, Nabil	City, University of London

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Vinicius, Goncalves	New York University
Krishnamurthy, Prashanth	New York University
Tzes, Anthony	New York University
Khorrami, Farshad	New York University

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Chair: Zhang, Youmin	Concordia University
Co-Chair: Ellinas, Georgios	University of Cyprus

16:30-16:50 TuC2.1

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Bonagura, Valeria	Roma Tre University
Foglietta, Chiara	Roma Tre University
Panzieri, Stefano	Roma Tre University
Pascucci, Federica	Roma Tre University

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Kazemi, MohamadGhasem	Concordia University
Khorasani, Khashayar	Concordia University
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Nobili, Martina	University Campus Bio-Medico of Rome
Fioravanti, Camilla	University Campus Bio-Medico of Rome
Guarino, Simone	University Campus Bio-Medico of Rome
Ansaldi, Silvia Maria	Italian National Institute for Insurance against Accidents
Milazzo, Maria Francesca	University of Messina
Bragatto, Paolo	University Campus Bio-Medico of Rome
Setola, Roberto	University Campus Bio-Medico of Rome
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Yang, Haichuan	Nanjing University of Aeronautics and Astronautics
Fu, Minrui	Nanjing University of Aeronautics and Astronautics
Yu, Ziquan	Nanjing University of Aeronautics and Astronautics
Zhang, Youmin	Concordia University
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Piperigkos, Nikos	University of Patras
Anagnostopoulos, Christos	Industrial Systems Institute / Athena Research Center
Lalos, Aris	Athena Research Center
Zukhraf, Syeda Zillay Nain	University of Cyprus
Laoudias, Christos	University of Cyprus
Michael, Maria K.	University of Cyprus
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Shangov, Daniel	Elektroenergien Sistemen Operator EAD
Ciornei, Irina	University of Cyprus
Hristov, Georgi	VivaCom
Velev, Valentin	Software Company
Antonopoulos, Angelos	Nearby Computing
Brodimas, Dimitrios	Independent Power Transmission
Ellinas, Georgios	University of Cyprus
Asprou, Markos	University of Cyprus
Rantopoulos, Michalis	Hellenic Telecommunications Organization S.A., OTE
Chochliouros, Ioannis	Hellenic Telecommunications Organization S.A., OTE

TuC3	Grand Hall C
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Chair: El Hajjaji, Ahmed	Univ. De Picardie-Jules Verne
Co-Chair: Alma, Marouane	CRAN, Université De Lorraine
16:30-16:50	TuC3.1
RL-Based Path Planning for Controller Performance Validation, pp. 424-429.	
Schichler, Lukas	Virtual Vehicle Research GmbH
Tieber, Karin	Virtual Vehicle Research GmbH
Stolz, Michael	Virtual Vehicle Research GmbH
Watzenig, Daniel	Virtual Vehicle Research GmbH
16:50-17:10	TuC3.2
Two-Level Steering Stability Control Based on Energy-Saving of a Four In-Wheel Motor Drive Electric Vehicle, pp. 430-435.	
Achdad, Reda	University of Picardie Jules Verne
Rabhi, Abdelhamid	University of Picardie Jules Verne
Pages, Olivier	University of Picardie Jules Verne

Bosche, Jerome	University of Picardie Jules Verne

17:10-17:30	TuC3.3

Observer-Based State Feedback Air Path Control for a Turbocharged Diesel Engine with EGR and VGT, pp. 436-441.

Djadane, Oussama	University of Picardy Jules Verne
Makni, Salama	University of Picardy Jules Verne
El Hajjaji, Ahmed	University of Picardy Jules Verne

17:30-17:50	TuC3.4

L 1-Functional Interval Observers for Continuous-Time Linear Parameter-Varying Multivariable Systems, pp. 442-447.

Mizouri, Hanin	National Engineering School of Gabes
Lamouchi, Rihab	National Engineering School of Gabes
Amairi, Messaoud	National Engineering School of Gabes

17:50-18:10	TuC3.5

Controllers Coordination for Diesel Engines NOx Emissions Management, pp. 448-453.

Ventura, Loris	Politecnico Di Torino
Malan, Stefano Alberto	Politecnico Di Torino

18:10-18:30	TuC3.6

Vehicle Rollover Index Estimation Using a Nonlinear Unknown Input Observer, pp. 454-459.

Codjia, Denakpo J.	University of Evry
Boutat-Baddas, Latifa	University of Lorraine
Alma, Marouane	University of Lorraine
Haddad, Madjid	SEGULA TECHNOLOGIES
Zemouche, Ali	University of Lorraine

TuC4	Tefkros
Developing an Ubiquitous Automation and Control Paradigm for Congested Transportation Systems (Invited Session)	
Chair: Geroliminis, Nikolas	Ecole Polytechnique Fédérale De Lausanne (EPFL), Urban Transport Systems Laboratory
Co-Chair: Lygeros, John	ETH Zurich
Organizer: Geroliminis, Nikolas	Ecole Polytechnique Fédérale De Lausanne (EPFL), Urban Transport Systems Laboratory
Organizer: Lygeros, John	ETH Zurich

16:30-16:50	TuC4.1

Two-Layer Adaptive Signal Control Framework for Large-Scale Networks (I), pp. 460-465.

Tsitsokas, Dimitrios	Ecole Polytechnique Fédérale De Lausanne (EPFL)
Kouvelas, Anastasios	ETH Zurich
Geroliminis, Nikolas	Ecole Polytechnique Fédérale De Lausanne (EPFL)

16:50-17:10	TuC4.2

Karma Priority Lanes for Fair and Efficient Bottleneck Congestion Management (I), pp. 466-471.

Elokda, Ezzat	ETH Zurich
Cenedese, Carlo	ETH Zurich
Zhang, Kenan	ETH Zurich
Censi, Andrea	MIT
Lygeros, John	ETH Zurich
Frazzoli, Emilio	ETH Zürich

17:10-17:30	TuC4.3

Integrated Optimal Control for Multi-Lane Motorway Networks (I), pp. 472-479.

Markantonakis, Vasileios	Technical University of Crete
Papamichail, Ioannis	Technical University of Crete

17:30-17:50	TuC4.4

Multi-Objective Optimization of Electric Autonomous Bus Trajectories Based on the Epsilon-Constraint Method (I), pp. 480-485.

Pasquale, Cecilia	University of Genova
Sacone, Simona	University of Genova
Siri, Silvia	University of Genova
Ferrara, Antonella	University of Pavia

17:50-18:10	TuC4.5

On the Effect of Capacity Drops in Highways with Service Stations (I), pp. 486-491.

Cenedese, Carlo	ETH Zurich
Lucchini, Matteo	University of Pavia
Cucuzzella, Michele	University of Pavia
Ferrara, Antonella	University of Pavia
Lygeros, John	ETH Zurich

18:10-18:30 TuC4.6

A Macroscopic Approach for the On-Time Arrival Problem (I), pp. 492-494.

Menelaou, Charalambos	University of Cyprus
Timotheou, Stelios	University of Cyprus
Panayiotou, Christos	University of Cyprus

TuC5 Evagoras

Intelligent Systems and Learning Methods in Control and Decision Support Systems (Invited Session)

Chair: Menegatti, Danilo	University of Rome "La Sapienza"
Co-Chair: Giuseppi, Alessandro	La Sapienza
Organizer: Menegatti, Danilo	University of Rome "La Sapienza"
Organizer: Giuseppi, Alessandro	La Sapienza
Organizer: De Santis, Emanuele	Sapienza University of Rome
Organizer: Manfredi, Sabato	University of Naples Federico II
Organizer: Pietrabissa, Antonio	Consorzio Per La Ricerca nell'Automatica E Nelle Telecomunicazioni (CRAT)

16:30-16:50 TuC5.1

Behavioural Cloning for Serious Games in Support of Pediatric Neurorehabilitation (I), pp. 495-500.

Baldisseri, Federico	Sapienza University of Rome
Montecchiani, Edoardo	Consortium for the Research in Automation and Telecommunication
Maiani, Arturo	Sapienza University of Rome
Menegatti, Danilo	Sapienza University of Rome
Giuseppi, Alessandro	Sapienza University of Rome
Pietrabissa, Antonio	Consortium for the Research in Automation and Telecommunication
Fogliati, Vincenzo	Consortium for the Research in Automation and Telecommunication
Delli Priscoli, Francesco	Sapienza University of Rome

16:50-17:10 TuC5.2

An Intelligent Ground Station Selection Algorithm in Satellite Optical Communications Via Deep Learning (I), pp. 501-507.

Wrona, Andrea	Sapienza University of Rome
De Santis, Emanuele	Sapienza University of Rome
Delli Priscoli, Francesco	Sapienza University of Rome
Lavacca, Francesco Giacinto	Sapienza University of Rome

17:10-17:30 TuC5.3

Load Demand Prediction for Electric Vehicles Smart Charging through Consensus-Based Federated Learning (I), pp. 508-514.

Menegatti, Danilo	Sapienza University of Rome
Pietrabissa, Antonio	Consortium for the Research in Automation and Telecommunication
Manfredi, Sabato	University of Naples Federico II
Giuseppi, Alessandro	Sapienza University of Rome

17:30-17:50 TuC5.4

Deep Image Inpainting to Support Endoscopic Procedures (I), pp. 515-520.

Menegatti, Danilo	Sapienza University of Rome
Betello, Filippo	Sapienza University of Rome
Delli Priscoli, Francesco	Sapienza University of Rome
Giuseppi, Alessandro	Sapienza University of Rome

17:50-18:10 TuC5.5

Landslide Susceptibility Prediction from Satellite Data through an Intelligent System Based on Deep Learning (I), pp. 521-528.

Giuseppi, Alessandro	Sapienza University of Rome
Lo Porto, Leonardo Pio	Sapienza University of Rome

Wrona, Andrea	Sapienza University of Rome
Menegatti, Danilo	Sapienza University of Rome

18:10-18:30 TuC5.6

Vertically-Advised Federated Learning for Multi-Strategic Stock Predictions through Stochastic Attention-Based LSTM (I), pp. 529-536.

Menegatti, Danilo	Sapienza University of Rome
Ciccarelli, Emanuele	Sapienza University of Rome
Viscione, Michele	Sapienza University of Rome
Giuseppi, Alessandro	Sapienza University of Rome

18:30-18:50 TuC5.7

Point2Depth: A GAN-Based Contrastive Learning Approach for mmWave Point Clouds to Depth Images Transformation (I), pp. 537-544.

Brescia, Walter	Politecnico Di Bari
Roberto, Giuseppe	Politecnico Di Bari
Racanelli, Vito Andrea	Politecnico Di Bari
Mascolo, Saverio	Politecnico Di Bari
De Cicco, Luca	Politecnico Di Bari

WeA1	Grand Hall A
Robotics (I) (Regular Session)	
Chair: Gasparri, Andrea	Università Degli Studi Roma Tre
Co-Chair: Tika, Argtim	RPTU Kaiserslautern

10:30-10:50	WeA1.1

Visual Imitation Learning for Robotic Fresh Mushroom Harvesting, pp. 545-550.

Porichis, Antonios	University of Essex
Vasios, Konstantinos	University of Essex
Iglezou, Myrto	TWI Hellas
Mohan, Vishwanathan	University of Essex
Chatzakos, Panagiotis	University of Essex

10:50-11:10	WeA1.2

An Optimal Allocation and Scheduling Method in Human-Multi-Robot Precision Agriculture Settings, pp. 551-556.

Lippi, Martina	Roma Tre University
Gallou, Jorand	Roma Tre University
Gasparri, Andrea	Roma Tre University
Marino, Alessandro	University of Cassino

11:10-11:30	WeA1.3

Tethering a Human with a Quadruped Robot: A Guide Dog to Help Visually Impaired People, pp. 557-563.

Morlando, Viviana	University of Naples Federico II
Lippiello, Vincenzo	University of Naples Federico II
Ruggiero, Fabio	University of Naples Federico II

11:30-11:50	WeA1.4

Energy and Angular Momentum Control of Robot Running, pp. 564-571.

Giordano, Alessandro Massimo	DLR (German Space Center), Technical University of Munich
Stivala, Simone	University of Trento
Calzolari, Davide	Technical University of Munich
Albu-Schäffer, Alin	Technical University of Munich, DLR (German Space Center)

11:50-12:10	WeA1.5

Optimization-Based Task and Trajectory Planning for Robot Manipulators, pp. 572-578.

Tika, Argtim	Rhineland-Palatinate Technical University Kaiserslautern-Landau
Bajcinca, Naim	Rhineland-Palatinate Technical University Kaiserslautern-Landau

12:10-12:30	WeA1.6

System Identification of an Elastomeric Series Elastic Actuator Using Black-Box models, pp. 579-585.

Fernandes, Diogo Lopes	Pontifical Catholic University of Rio De Janeiro
Hultmann Ayala, Helon Vicente	Pontifical Catholic University of Rio De Janeiro
Meggiolaro, Marco Antonio	Pontifical Catholic University of Rio De Janeiro

WeA2	Grand Hall B
Computational Intelligence (Regular Session)	
Chair: Puig, Vicenç	Universitat Politècnica De Catalunya (UPC)
Co-Chair: Stamatescu, Grigore	University Politehnica of Bucharest

10:30-10:50	WeA2.1

Evaluation of Deep Learning and Machine Learning Algorithms for Building Occupancy Classification on Open Datasets, pp. 586-591.

Cretu, Georgiana Madalina	Polytechnic University of Bucharest
Stamatescu, Iulia	Polytechnic University of Bucharest
Stamatescu, Grigore	Polytechnic University of Bucharest

10:50-11:10	WeA2.2

Nonlinear State Observer for PMSM with Evolutionary Algorithm, pp. 592-597.

Bazylev, Dmitry	ITMO University
Pyrkin, Anton	ITMO University
Dobriborsci, Dmitrii	Deggendorf Institute of Technology

11:10-11:30	WeA2.3

Analyzing the Effects of Confidence Thresholds on Opinion Clustering in Homogeneous Hegselmann–Krause Models,

pp. 598-603.

Srivastava, Trisha	University of Sannio
Bernardo, Carmela	Linköping University
Altafini, Claudio	Linköping University
Vasca, Francesco	University of Sannio

11:30-11:50 WeA2.4

FedAcc and FedAccSize: Aggregation Methods for Federated Learning Applications, pp. 604-609.

Bejenar, Iuliana - Alexandra	Gheorghe Asachi Technical University of Iasi
Ferariu, Lavinia	Gheorghe Asachi Technical University of Iasi
Pascal, Carlos	Gheorghe Asachi Technical University of Iasi
Caruntu, Constantin-Florin	Gheorghe Asachi Technical University of Iasi

11:50-12:10 WeA2.5

A Generalized Approach for Feature Selection in Water Quality Monitoring, pp. 610-615.

Pavone, Marino	University of L'Aquila
Epicoco, Nicola	Free Mediterranean University
Magliocca, Francesco	Sensichips Srl
Pola, Giordano	University of L'Aquila

12:10-12:30 WeA2.6

Gaussian Sampling Approach to Deal with Imbalanced Telemetry Datasets in Industrial Applications, pp. 616-622.

Galve, Sergio	Universitat Oberta De Catalunya
Puig, Vicenç	Universitat Politècnica De Catalunya (UPC)
Vilajosana, Xavi	Universitat Oberta De Catalunya

WeA3 — Grand Hall C

Nonlinear Control (I) (Regular Session)

Chair: El hajjaji, Ahmed	University of Picardie Jules Verne
Co-Chair: Sacchi, Nikolas	University of Pavia

10:30-10:50 WeA3.1

Adaptive Integral Sliding Mode Control for Constrained Quadrotor Trajectory Tracking, pp. 623-628.

Sidi Brahim, Khelil	University of Picardy Jules Verne
El hajjaji, Ahmed	University of Picardy Jules Verne
Terki, Nadjiba	University of Biskra
Lara David, David	Higher Technological Institute of Misantla

10:50-11:10 WeA3.2

Sliding Mode Control for a Class of Systems Based on a Non-Monotonic Lyapunov Function, pp. 629-634.

Prasun, Parijat	Indian Institute of Technology, Varanasi
Singh, Vijay Kumar	Indian Institute of Technology, Varanasi
Pandey, Vinay	Indian Institute of Technology, Varanasi
Kamal, Shyam	Indian Institute of Technology, Varanasi
Ghosh, Sandip	Indian Institute of Technology, Varanasi
Osinenko, Pavel	Skoltech
Parsegov, Sergei	Institute of Control Sciences, Russian Academy of Sciences

11:10-11:30 WeA3.3

Neural Network Based Integral Sliding Mode Control of Systems with Time-Varying State Constraints, pp. 635-640.

Sacchi, Nikolas	University of Pavia
Vacchini, Edoardo	University of Pavia
Ferrara, Antonella	University of Pavia

WeA4 — Tefkros

Robust Control and Estimation (Regular Session)

Chair: Gershon, Eli	Holon Institue of Technology
Co-Chair: Nesci, Francesca	Universita' Degli Studi Magna Graecia Di Catanzaro

10:30-10:50 WeA4.1

Mixed FTS/H∞ Control for Nonlinear Quadratic Systems Subject to Norm-Bounded Disturbances, pp. 641-646.

Merola, Alessio	Magna Græcia University of Catanzaro
Nesci, Francesca	Magna Græcia University of Catanzaro
Dragone, Donatella	Magna Græcia University of Catanzaro

Amato, Francesco	University of Naples Federico II
Cosentino, Carlo	Magna Græcia University of Catanzaro

10:50-11:10 WeA4.2

Robust Sparse Filtering under Bounded Exogenous Disturbances, pp. 647-652.

Khlebnikov, Mikhail	V. A. Trapeznikov Institute of Control Sciences, RAS
Tremba, Andrey	V. A. Trapeznikov Institute of Control Sciences, RAS

11:10-11:30 WeA4.3

Anisotropy-Based Approach of Estimating for Sensors Network with Nonzero Mean of Input, pp. 653-658.

Yurchenkov, Alexander	V. A. Trapeznikov Institute of Control Sciences
Kustov, Arkadiy	V. A. Trapeznikov Institute of Control Sciences

11:30-11:50 WeA4.4

State Estimation for Stochastic State Multiplicative Systems, pp. 659-663.

Gershon, Eli	Holon Institue of Technology

11:50-12:10 WeA4.5

Terminal-Set-Based Optimal Stochastic Guidance, pp. 664-669.

Mudrik, Liraz	Technion - Israel Institute of Technology
Oshman, Yaakov	Technion - Israel Institute of Technology

WeA5 Evagoras

Distributed Systems (Regular Session)

Chair: Horn, Joachim	Helmut-Schmidt-University / University of the Federal Armed Forces Hamburg
Co-Chair: Petrillo, Alberto	University of Naples Federico II

10:30-10:50 WeA5.1

Distributed Consensus Control of Homogeneous Vehicle Platoons with Bidirectional Communication, pp. 670-677.

Gaagai, Ramzi	Helmut Schmidt University
Seeland, Felix	Helmut Schmidt University
Horn, Joachim	Helmut Schmidt University

10:50-11:10 WeA5.2

Cooperative Adaptive Cruise Control of Heterogeneous Vehicle Platoons with Bidirectional Communication, pp. 678-684.

Gaagai, Ramzi	Helmut Schmidt University
Seeland, Felix	Helmut Schmidt University
Horn, Joachim	Helmut Schmidt University

11:10-11:30 WeA5.3

Adaptive Distributed PI-Like Control Protocol for the Virtual Coupling of Connected Heterogeneous Uncertain Nonlinear High-Speed Trains, pp. 685-690.

Petrillo, Alberto	University of Naples Federico II
Basile, Giacomo	University of Naples Federico II
Lui, Dario Giuseppe	University of Naples Federico II
Santini, Stefania	University of Naples Federico II

11:30-11:50 WeA5.4

Dynamic Centrality in Metapopulation Networks: Incorporating Dynamics and Network Structure, pp. 691-696.

Darabi, Atefe	Northeastern University
Siami, Milad	Northeastern University

11:50-12:10 WeA5.5

Fundamental Limits on Disturbance Propagation in Virtual Viscoelastic-Based Multi-Agent Systems, pp. 697-702.

Murugan, Dinesh	Northeastern University
Hajian, Rozhin	University of Massachusetts Lowell
Siami, Milad	Northeastern University

WeB1 Grand Hall A

Robotics (II) (Regular Session)

Chair: Fourlas, George K.	University of Thessaly
Co-Chair: Koval, Anton	Luleå University of Technology

14:00-14:20 WeB1.1

Linearized Model Predictive Control with Offset-Freeness for Trajectory Tracking on Inland Vessels, pp. 703-708.

Marx, Johannes Richard	University of Rostock
Damerius, Robert	University of Rostock
Jeinsch, Torsten	University of Rostock

14:20-14:40 WeB1.2

Modelling and Workspace Analysis for an Underwater Manipulator, pp. 709-714.

Lack, Sven	University of Rostock
Rentzow, Erik	University of Rostock
Jeinsch, Torsten	University of Rostock

14:40-15:00 WeB1.3

Tube-Based Nonlinear MPC of an Over-Actuated Marine Platform for Navigation and Obstacle Avoidance Using Control Barrier Functions, pp. 715-720.

Syntakas, Spyridon	University of Ioannina
Vlachos, Kostas	University of Ioannina

15:00-15:20 WeB1.4

Control Barrier Function Based Visual Servoing for Underwater Vehicle Manipulator Systems under Operational Constraints, pp. 721-726.

Heshmati Alamdari, Shahab	Aalborg University
Karras, George	University of Thessaly
Sharifi, Maryam	ABB Corporate Research
Fourlas, George K.	University of Thessaly

15:20-15:40 WeB1.5

Multimodal Dataset from Harsh Sub-Terranean Environment with Aerosol Particles for Frontier Exploration, pp. 727-732.

Kyuroson, Alexander	Luleå University of Technology
Dahlquist, Niklas	Luleå University of Technology
Stathoulopoulos, Nikolaos	Luleå University of Technology
Kottayam Viswanathan, Vignesh	Luleå University of Technology
Koval, Anton	Luleå University of Technology
Nikolakopoulos, George	Luleå University of Technology

WeB2 Grand Hall B

Intelligent Control Systems (Regular Session)

Chair: Goodwine, Bill	University of Notre Dame
Co-Chair: Timotheou, Stelios	University of Cyprus

14:00-14:20 WeB2.1

Staggered School Schedules for the Morning Commute Problem - an MFD-Based Optimization Approach, pp. 733-738.

Georgantas, Antonios	University of Cyprus
Menelaou, Charalambos	University of Cyprus
Timotheou, Stelios	University of Cyprus
Panayiotou, Christos	University of Cyprus

14:20-14:40 WeB2.2

Decentralized and Compositional Interconnection Topology Synthesis for Linear Networked Systems, pp. 739-744.

Welikala, Shirantha	University of Notre Dame
Lin, Hai	University of Notre Dame
Antsaklis, Panos J.	University of Notre Dame

14:40-15:00 WeB2.3

Modeling and Control of a Hybrid PV-T Collector Using Machine Learning, pp. 745-750.

Ul Abdin, Zain	University of Picardy Jules Verne
Rachid, Ahmed	University of Picardy Jules Verne

15:00-15:20 WeB2.4

Fictitious Reference Iterative Tuning of Intelligent Proportional-Integral Controllers for Tower Crane Systems, pp. 751-757.

Roman, Raul-Cristian	Polytechnic University of Timisoara
Precup, Radu-Emil	Polytechnic University of Timisoara
Petriu, Emil	University of Ottawa
Muntyan, Mihai	Polytechnic University of Timisoara
Hedrea, Elena-Lorena	Polytechnic University of Timisoara

15:20-15:40 WeB2.5

Fractional-Order Dynamics in Large Scale Control Systems, pp. 758-763.

Goodwine, Bill	University of Notre Dame

15:40-16:00 WeB2.6

Predicting Opinions in Social Networks Using Recurrent Neural Networks, pp. 764-769.

Zareer, Mohamed	Mohamed Zareer
Selmic, Rastko	Concordia University

WeB3 Grand Hall C

Nonlinear Control (II) (Regular Session)

Chair: Ferrentino, Enrico	University of Salerno
Co-Chair: Fotiadis, Filippos	Georgia Institute of Technology

14:00-14:20 WeB3.1

Discrete Fully Probabilistic Design: Towards a Control Pipeline for the Synthesis of Policies from Examples, pp. 770-775.

Ferrentino, Enrico	University of Salerno
Chiacchio, Pasquale	University of Salerno
Russo, Giovanni	University of Salerno

14:20-14:40 WeB3.2

Achieving Prescribed Performance for Uncertain Impulsive Systems in Brunovsky Canonical Form, pp. 776-781.

Kechagias, Andreas	Aristotle University of Thessaloniki
Rovithakis, George A.	Aristotle University of Thessaloniki

14:40-15:00 WeB3.3

Construction of Control Lyapunov Function with Region of Attraction Using Union Theorem in Sum-Of-Squares Optimization, pp. 782-787.

Biswas, Bhaskar	Cranfield University
Ignatyev, Dmitry	Cranfield University
Zolotas, Argyrios	Cranfield University
Tsourdos, Antonios	Cranfield University

15:00-15:20 WeB3.4

Input-Constrained Prescribed Performance Control for SISO Nonlinear Systems Via Reference Relaxation, pp. 788-793.

Fotiadis, Filippos	Georgia Institute of Technology
Rovithakis, George A.	Aristotle University of Thessaloniki

15:20-15:40 WeB3.5

Discrete-Time Gradient Systems Governed by Difference Equation with Minima, pp. 794-799.

Prasun, Parijat	Indian Institute of Technology, Varanasi
Pandey, Sunidhi	Indian Institute of Technology, Varanasi
Kamal, Shyam	Indian Institute of Technology, Varanasi
Ghosh, Sandip	Indian Institute of Technology, Varanasi
Singh, Devender	Indian Institute of Technology, Varanasi

WeB4 Telfkros

Linear Systems (Regular Session)

Chair: Nguyen, Ba Huy	Institute for Problems in Mechanical Engineering of the Russian Academy of Sciences
Co-Chair: Konovalov, Dmitry	ITMO University

14:00-14:20 WeB4.1

Extended Adaptive Observer for Linear Systems with Overparameterization, pp. 800-805.

Glushchenko, Anton	V. A. Trapeznikov Institute of Control Sciences
Lastochkin, Konstantin	V. A. Trapeznikov Institute of Control Sciences

14:20-14:40 WeB4.2

Parameter Estimation-Based Observer for Linear Systems with Polynomial Overparameterization, pp. 806-810.

Glushchenko, Anton	V. A. Trapeznikov Institute of Control Sciences
Lastochkin, Konstantin	V. A. Trapeznikov Institute of Control Sciences

14:40-15:00 WeB4.3

Design Constraints in the Synthesis of Control of Positive Linear Discrete-Time Systems, pp. 811-816.

Krokavec, Dusan	Technical University of Kosice
Filasova, Anna	Technical University of Kosice

15:00-15:20 WeB4.4

Observer-Based Control MIMO Linear Systems with Providing Output in Given Set, pp. 817-822.

Nguyen, Ba Huy — Institute for Problems in Mechanical Engineering, RAS
Hoang, Anh Phuong — ITMO University
Phung, Van Quy — ITMO University

15:20-15:40 WeB4.5

Finite-Time Observer Design for Linear Descriptor Systems, pp. 823-828.

Konovalov, Dmitry — ITMO University
Zimenko, Konstantin — ITMO University
Kremlev, Artem — ITMO University
Margun, Alexey — ITMO University
Dobriborsci, Dmitrii — Deggendorf Institute of Technology
Aumer, Wolfgang — Deggendorf Institute of Technology

WeB5 Evagoras

Multi-Agent Systems (Regular Session)

Chair: Wang, Wei — KTH Royal Institute of Technology in Stockholm
Co-Chair: Wang, Zeyuan — University of Paris-Saclay

14:00-14:20 WeB5.1

Improved Dynamic Event-Triggered Consensus Control for Multi-Agent Systems with Designable Inter-Event Time, pp. 829-834.

Wang, Zeyuan — University of Paris-Saclay
Chadli, M. — University of Paris-Saclay

14:20-14:40 WeB5.2

Modifying Neural Networks in Adversarial Agents of Multi-Agent Reinforcement Learning Systems, pp. 835-840.

Elhami Fard, Neshat — Concordia University
Selmic, Rastko — Concordia University

14:40-15:00 WeB5.3

Distributed Event-Triggered Leader-Follower Consensus of Nonlinear Multi-Agent Systems, pp. 841-846.

Marchand, Mathieu — ONERA
Andrieu, Vincent — University of Lyon
Bertrand, Sylvain — ONERA
Piet-Lahanier, Hélène — ONERA

15:00-15:20 WeB5.4

Platoons Coordination Based on Decentralized Higher Order Barrier Certificates, pp. 847-852.

Sharifi, Maryam — ABB Corporate Research
Dimarogonas, Dimos V. — KTH Royal Institute of Technology

15:20-15:40 WeB5.5

Decentralized Multi-Agent Coordination under MITL Specifications and Communication Constraints, pp. 853-860.

Wang, Wei — KTH Royal Institute of Technology
Schuppe, Georg — KTH Royal Institute of Technology
Tumova, Jana — KTH Royal Institute of Technology

15:40-16:00 WeB5.6

Improved Simultaneous Perturbation Stochastic Approximation-Based Consensus Algorithm for Tracking, pp. 861-866.

Erofeeva, Victoria — Institute for Problems in Mechanical Engineering, RAS
Granichin, Oleg — Saint Petersburg State University

ThA1	Grand Hall A
Adaptive Control (Regular Session)	
Chair: Horn, Joachim	Helmut-Schmidt-University / University of the Federal Armed Forces Hamburg
Co-Chair: Schwung, Andreas	Fachhochschule Südwestfalen

10:30-10:50 ThA1.1

Adaptive Compensation Disturbance for Linear Systems with Input Delay, pp. 867-872.

Nguyen, Khac Tung	ITMO University
Vlasov, Sergey	ITMO University
Dobriborsci, Dmitrii	Deggendorf Institute of Technology
Pyrkin, Anton	ITMO University

10:50-11:10 ThA1.2

Neural Network-Based Control for Affine Formation Maneuver of Multi-Agent Systems with External Disturbances, pp. 873-878.

Maaruf, Muhammad	King Fahd University of Petroleum and Minerals
Sami, El-ferik	King Fahd University of Petroleum and Minerals
AL-Sunni, Fouad	King Fahd University of Petroleum and Minerals

11:10-11:30 ThA1.3

Adaptive Speed Control of ROVs with Experimental Results from an Aquaculture Net Pen Inspection Operation, pp. 879-886.

Ohrem, Sveinung Johan	SINTEF Ocean
Evjemo, Linn Danielsen	SINTEF Ocean
Haugaløkken, Bent Oddvar Arnesen	SINTEF Ocean
Amundsen, Herman Biørn	Norwegian University of Science and Technology
Kelasidi, Eleni	SINTEF Ocean

11:30-11:50 ThA1.4

Adaptive Optimal Control of Heterogeneous Vehicle Platoons with Bidirectional Communication and Uncertain Dynamics, pp. 887-893.

Gaagai, Ramzi	Helmut Schmidt University
Seeland, Felix	Helmut Schmidt University
Horn, Joachim	Helmut Schmidt University

11:50-12:10 ThA1.5

Model Predictive Control with Adaptive PLC-Based Policy on Low Dimensional State Representation for Industrial Applications, pp. 894-900.

Yuwono, Steve	South Westphalia University of Applied Sciences
Schwung, Andreas	South Westphalia University of Applied Sciences

12:10-12:30 ThA1.6

Robust Compensation of External Disturbances for a Class of Linear Systems with State-Delay, pp. 901-906.

Bui, Van Huan	ITMO University
Margun, Alexey	ITMO University
Kremlev, Artem	ITMO University
Dobriborsci, Dmitrii	Deggendorf Institute of Technology

ThA2	Grand Hall B
Predictive Control (Regular Session)	
Chair: Svec, Marko	University of Zagreb, Faculty of Electrical Engineering and Computing
Co-Chair: Voulgaris, Petros	University of Nevada

10:30-10:50 ThA2.1

Model Predictive Control for Path Following and Collision-Avoidance of Autonomous Ships in Inland Waterways, pp. 907-914.

Mahipala, Dhanika	Norwegian University of Science and Technology
Johansen, Tor Arne	Norwegian University of Science and Technology

10:50-11:10 ThA2.2

Encrypted Model Predictive Control of Nonlinear Systems, pp. 915-922.

Suryavanshi, Atharva Vijay	University of California, Los Angeles

Alnajdi, Aisha Musaad	University of California, Los Angeles
Alhajeri, Mohammed Saeed	Kuwait University
Abdullah, Fahim	University of California, Los Angeles
Christofides, Panagiotis D.	University of California, Los Angeles

11:10-11:30 ThA2.3

Partially-Connected Recurrent Neural Network Model Generalization Error: Application to Model Predictive Control of Nonlinear Processes, pp. 923-930.

Alhajeri, Mohammed Saeed	Kuwait University
Alnajdi, Aisha Musaad	University of California, Los Angeles
Abdullah, Fahim	University of California, Los Angeles
Christofides, Panagiotis D.	University of California, Los Angeles

11:30-11:50 ThA2.4

Testing Nonlinear Predictive Torque Vectoring on a Scaled Car Driving on a Roadway Simulator, pp. 931-936.

Svec, Marko	University of Zagreb
Kir Hromatko, Josip	University of Zagreb
Iles, Sandor	University of Zagreb

11:50-12:10 ThA2.5

Adaptive Risk Sensitive Path Integral for Model Predictive Control Via Reinforcement Learning, pp. 937-942.

Yoon, Hyung-Jin	University of Nevada
Tao, Chuyuan	University of Illinois at Urbana-Champaign
Kim, Hunmin	Mercer University
Hovakimyan, Naira	University of Illinois at Urbana-Champaign
Voulgaris, Petros	University of Nevada

12:10-12:30 ThA2.6

Cascaded Disturbance Compensation for MPC-Based Autonomous Vehicle Guidance, pp. 943-948.

Jalilian, Arash	IAV GmbH
Schwarz, Norman	Sedenius Engineering GmbH
Völz, Andreas	University of Erlangen–Nuremberg
Ritschel, Robert	IAV GmbH

ThA3 Grand Hall C

Industrial Automation and Manufacturing (Regular Session)

Chair: Leva, Alberto	Politecnico Di Milano
Co-Chair: Fragkoulis, Dimitrios	National and Kapodistrian University of Athens

10:30-10:50 ThA3.1

Safe Operation of a Modular Production System Via Supervisor Automata, pp. 949-956.

Koumboulis, Fotis N.	National and Kapodistrian University of Athens
Fragkoulis, Dimitrios	National and Kapodistrian University of Athens
Siake, Benise	National and Kapodistrian University of Athens

10:50-11:10 ThA3.2

Cutting Unequal Rectangular Boards from Cylindrical Logs in Wood Products Manufacturing: A Heuristic Approach, pp. 957-964.

Hosseini, Seyed Mohsen	Free University of Bozen-Bolzano
Frego, Marco	University of Trento
Peer, Angelika	Technical University of Munich

11:10-11:30 ThA3.3

Distributed State Estimation for Multi-Area Data Reconciliation, pp. 965-970.

Erofeeva, Victoria	Institute for Problems in Mechanical Engineering, RAS
Parsegov, Sergei	Institute of Control Sciences, RAS
Osinenko, Pavel	Skoltech
Kamal, Shyam	Indian Institute of Technology (BHU), Varanasi

11:30-11:50 ThA3.4

Automated Cross Channel Temperature Predictions for the PFR Lime Kiln Operating Support, pp. 971-977.

Kychkin, Aleksei	Software Competence Center Hagenberg GmbH
Chasparis, Georgios	Software Competence Center Hagenberg GmbH
Ellero, Stefano	Stam S.r.l

11:50-12:10 ThA3.5

Sensor Selection for High-Dimensional Swarm Systems Based on Observability Analysis, pp. 978-984.

Meng, Qingkai	University of Cyprus
Polycarpou, Marios M.	University of Cyprus

12:10-12:30 ThA3.6

Wireless Synchronisation As a Control Problem Embedded in New-Generation Networked Automation Systems, pp. 985-990.

Leva, Alberto	Politecnico Di Milano
Terraneo, Federico	Politecnico Di Milano
Fornaciari, William	Politecnico Di Milano

ThA4 Tefkros

Analytical Methods for Control Design and Qualitative Study of Complex Dynamical Systems (Invited Session)

Chair: Sklyar, Grigory	West Pomeranian University of Technology
Co-Chair: Zuyev, Alexander	Otto Von Guericke University Magdeburg
Organizer: Sklyar, Grigory	West Pomeranian University of Technology
Organizer: Zuyev, Alexander	Otto Von Guericke University Magdeburg

10:30-10:50 ThA4.1

Dynamic Morphing of Trailing-Edge (I), pp. 991-993.

Svoboda, Filip	Czech Technical University in Prague
Tomáš, Čenský	Czech Technical University in Prague
Hromcik, Martin	Czech Technical University in Prague

10:50-11:10 ThA4.2

On Classical Solutions of the Stabilization Problem for Nonholonomic Systems with Time-Varying Feedback Laws (I), pp. 994-996.

Zuyev, Alexander	Otto Von Guericke University Magdeburg
Grushkovskaya, Victoria	Alpen-Adria University of Klagenfurt

11:10-11:30 ThA4.3

Periodic Optimization of a Hyperbolic Control System with Application to Nonlinear Chemical Reactions (I), pp. 997-999.

Yevgenieva, Yevgeniia	Max Planck Institute for Dynamics of Complex Technical Systems
Zuyev, Alexander	Otto Von Guericke University Magdeburg
Benner, Peter	Max Planck Institute for Dynamics of Complex Technical Systems
Seidel-Morgenstern, Andreas	Max Planck Institute for Dynamics of Complex Technical Systems

11:30-11:50 ThA4.4

Some Notes on the Asymptotic Behavior of Unbounded Semigroups on the Domain of the Generator, pp. 1000-1004.

Sklyar, Grigory	West Pomeranian University of Technology
Polak, Piotr	University of Szczecin
Wasilewski, Bartosz	University of Szczecin

11:50-12:10 ThA4.5

Exact Observability for a System of Coupled Wave Equations, pp. 1005-1008.

Wozniak, Jaroslaw	West Pomeranian University of Technology in Szczecin

12:10-12:30 ThA4.6

Linearizability Problem and Invariants for Multi-Input Non-Autonomous Control Systems, pp. 1009-1014.

Sklyar, Jekatierina	West Pomeranian University of Technology
Ignatovich, Svetlana	V.N. Karazin Kharkiv National University
Sklyar, Grigory	West Pomeranian University of Technology

ThA5 Evagoras

Biomedical Engineering (Regular Session)

Chair: Toffanin, Chiara	University of Pavia
Co-Chair: Horváth, Gergely	Pázmány Péter Catholic University

10:30-10:50 ThA5.1

Automatic Setup of a Pulse Duplicator Apparatus through a Dither-Free ESC Approach, pp. 1015-1020.

Manzoni, Eleonora	University of Padova
Rampazzo, Mirco	University of Padova
Di Micco, Luigi	University of Padova
Susin, Francesca Maria	University of Padova

10:50-11:10 ThA5.2

Quantifying and Comparing the Impact of Combinations of Non-Pharmaceutical Interventions on the Spread of COVID-19, pp. 1021-1026.

Horváth, Gergely	Pazmany Peter Catholic University
Szederkényi, Gábor	Pazmany Peter Catholic University
Reguly, István Zoltán	Pazmany Peter Catholic University

11:10-11:30 ThA5.3

Personalized LSTM-Based Alarm Systems for Hypoglycemia Prevention, pp. 1027-1032.

Toffanin, Chiara	University of Pavia
Iacono, Francesca	University of Pavia
Magni, Lalo	University of Pavia

Technical Program for Tuesday June 27, 2023

TuA1 Grand Hall A

Unmanned Systems (Regular Session)

Chair: Novak, Dora — Université Paris-Saclay, CentraleSupélec, CNRS, Laboratoire Des Signaux Et Systèmes

Co-Chair: Hegedus, Tamas — Budapest University of Technology and Economics

10:30-10:50 TuA1.1

Towards Efficient Traffic State Estimation Using Sparse UAV-Based Data in Urban Networks, pp. 1-6

Theocharides, Kyriacos — University of Cyprus
Menelaou, Charalambos — University of Cyprus
Englezou, Yiolanda — University of Cyprus
Timotheou, Stelios — University of Cyprus

Traffic state estimation (TSE) is a challenging task due to the collection of sparse and noisy measurements from fixed points in the traffic network. Unmanned Aerial Vehicles (UAVs) have been gaining popularity as traffic sensors due to their ability to monitor a number of important traffic parameters over space and time. In this work, we develop a novel UAV-based sensing architecture which provides sparse, noisy measurements of traffic densities and transfer flows of the traffic network. Assuming free-flow conditions, we construct a Kalman filter approach that utilises knowledge of regional split ratios along with the UAV-based measurements. To avoid the assumption of known split ratios, we further develop a weighted least-squares optimization approach that minimizes measurement and process errors over a moving horizon window subject to linear traffic dynamics to accurately estimate traffic densities. We compare the UAV-based sensing architecture to an all-measurement method where we assume that measurements for all traffic densities and transfer flows are available at every time-step. Results show that the UAV-based sensing architecture compares favourably to the all-measurement scenario and the proposed optimization based estimator achieves similar results to the Kalman filter, even when regional split ratios are unknown.

10:50-11:10 TuA1.2

Nonlinear MPC for the Multi-UAV System with Allocated Priority for Collision Avoidance, pp. 7-12

Novak, Dora — University of Paris-Saclay
Tebbani, Sihem — University of Paris-Saclay

This paper presents a nonlinear model predictive control (NMPC) approach for trajectory tracking of a multi-UAV system with a high risk of collision. The proposed solution focuses on minimizing unnecessary complex maneuvers while ensuring collision avoidance without compromising the final position accuracy. Allocating different levels of passing priority to the agents enables fewer alternations of the initially planned path as only the agents with lower passing priority handle collision avoidance when the risk arises. The agent with a higher passing priority tracks its reference trajectory along the planned path, without considering collision avoidance. This strategy aims to perform fewer alternations and aggressive maneuvers resulting in increased safety of the multi-UAV mission. All the agents solve an unconstrained optimal control problem in a distributed manner, as collision avoidance is also defined as a cost function term that penalizes the proximity between the agents. Finally, the performance of the proposed approach is studied in simulation in the case of a two-quadcopter mission, highlighting its efficiency and robustness against external disturbances and model uncertainties.

11:10-11:30 TuA1.3

UAV-Based System for Real-Time Wildfire Perimeter Propagation Tracking, pp. 13-18

Heracleous, Constantinos — University of Cyprus
Kolios, Panayiotis — University of Cyprus
Panayiotou, Christos — University of Cyprus

Real-time wildfire perimeter tracking provides situational awareness and enhances decision-making during firefighting. This paper proposes a UAV-based system that integrates real-time data collection (using onboard sensors) into a fire propagation model to provide accurate state information on the wildfire perimeter and improve fire prediction. Firstly, a data fusion scheme is devised to employ available historical data in combination with real-time measurements to provide updated inputs to the fire propagation model. Then the model is used to predict the future fire perimeter and uses these predictions to guide the UAV to track the fire perimeter better. The proposed system is evaluated in extensive simulation experiments, demonstrating its effectiveness for real-time wildfire perimeter propagation tracking.

11:30-11:50 TuA1.4

Cooperation Strategy for Optimal Motion of Aerial and Ground Vehicles, pp. 19-24

Hegedus, Tamas — SZTAKI Institute for Computer Science and Control
Fenyes, Daniel — SZTAKI Institute for Computer Science and Control
Nemeth, Balazs — SZTAKI Institute for Computer Science and Control
Gaspar, Peter — SZTAKI Institute for Computer Science and Control

In this paper, a route selection algorithm is proposed for aerial and ground vehicle cooperative control. The main goal is to determine a feasible trajectory for a drone, which satisfies several limitations. Moreover, during the route selection, the flight time is also minimized to increase the efficiency of the entire system. The route selection is performed by a graph-based method, which is evaluated for different initial conditions. Then, the proposed algorithm determines the trajectories for the drone, and the predefined limitations are also considered. The method is validated in a MATLAB-based simulation environment, in which the whole algorithm is implemented.

TuA2	Grand Hall B
Fault Diagnosis (Regular Session)	
Chair: Theilliol, Didier	CNRS_University of Lorraine
Co-Chair: Puig, Vicenç	Universitat Politècnica De Catalunya (UPC)

10:30-10:50 TuA2.1

Assessing a Statistical and a Set-Based Approach for Remaining Useful Life Prediction, pp. 31-36

Khoury, Boutrous — Universitat Politècnica De Catalunya (UPC)
Thuillier, Julien — CNES
Jha, Mayank Shekhar — University of Lorraine
Puig, Vicenç — Universitat Politècnica De Catalunya (UPC)
Theilliol, Didier — University of Lorraine

In this paper, an assessment of two methods of uncertainty quantification in prognostics is under-taken. Two methods, the Inverse First Order Reliability Method (IFORM) and set-based reachability analysis for prognostics are considered. By quantifying the uncertainties using the IFORM, an assessment of the quality of Remaining Useful Life (RUL) prediction. The IFORM approach permits the generation of confidence bounds that allows for the calculation of RUL values corresponding to the specified user-based probability levels. On the other hand, uncertainty quantification can be achieved by means of set-based reachability analysis. A Zonotopic Kalman filter (ZKF) is proposed to take into account a damage-model such that at each propagation time, with the estimated state (degradation) and its uncertainty, a propagation of zonotopic sets can be produced. Coming from two different schools of thought, the statistical and set-based theory, both schemes are explored and tested on a case study in simulation.

10:50-11:10 TuA2.2

Incipient Current and Voltage Sensors Fault Diagnosis Scheme for Grid Side Converters, pp. 37-42

Mehmood, Faizan — University of Cyprus
Hadjidemetriou, Lenos — University of Cyprus
Tzortzis, Ioannis — University of Cyprus
Polycarpou, Marios M. — University of Cyprus

This paper proposes a model-based fault diagnosis scheme for incipient faults in the DC voltage and AC current sensors of the grid-tied converter, considering the coupling phenomena between the two sides of the converter that might cause fault propagation. First, a linear descriptor estimator is designed, based on a linear augmented descriptor model of a nonlinear grid side converter (GSC) system, while considering the effect of sensor noise and modeling uncertainty. Second, a time varying estimator gain matrix for the design of the descriptor estimator is obtained by minimizing the sum of the variances of the estimation error. Lastly, the diagnosis of incipient sensor faults is designed using the derived analytical redundancy relations, based on the estimations provided by linear descriptor estimator. The results of this work are useful for the early diagnosis of incipient sensor faults, which can improve the safety and reliability of GSCs.

11:10-11:30 TuA2.3

Distributed Adaptive Observer-Based Fault Diagnosis for an Intensified Heat Exchanger/Reactor, pp. 43-48

Han, Xue — University of Caen
He, Menglin — Guizhou University
Di Miceli Raimondi, Nathalie — University of Toulouse
Cabassud, Michel — University Paul Sabatier
Dahhou, Boutaieb — University of Toulouse

In this paper, a new distributed adaptive observer-based fault detection and isolation (FDI) approach is developed for an intensified interconnected heat exchanger/reactor. In the distributed FDI architecture, an FDI component is designed for each subsystem in the interconnected system. For each FDI component, multiple adaptive observers, which correspond to the possible faulty parameters of the corresponding subsystem, are designed to monitor the states and derive a local diagnostic decision. Thanks to the parameter estimations provided by the adaptive observers, both local and global faults could be isolated and identified. Simulation results show that this method can quickly and accurately diagnose different types of faults occurring in the interconnected heat exchanger/reactor system.

11:30-11:50 TuA2.4

Relaxed Fault Estimation Conditions for Fuzzy Systems Subject to Time Varying Actuator and Sensor Faults, pp. 49-54

Makni, Salama — University of Picardy Jules Verne
El Hajjaji, Ahmed — University of Picardy Jules Verne
Chaabane, Mohamed — National Engineering School of Sfax, Tunisia

This paper investigates the problem of state and actuator/sensor fault (ASF) estimation for nonlinear systems described by Takagi-Sugeno (T-S) fuzzy models subject to external disturbances. A robust adaptive observer (RAO) is designed to estimate the system state, sensor faults and actuator faults conjointly. For the convergence analysis of all estimation errors, a fuzzy Lyapunov functional candidate combined by free weighting matrices have been constructed to obtain more relaxed results. The design conditions, taking into account the H_infty performance, are formulated in terms of Linear Matrix Inequalities (LMIs). Finally, a comparative study is presented to prove the superiority of the proposed method.

11:50-12:10 TuA2.5

Dynamic Modelling for Non-Stationary Bearing Vibration Signals, pp. 55-60

Galli, Federica — IRSEEM/ESIGELEC
Sircoulomb, Vincent — IRSEEM/ESIGELEC
Fiore, Giuseppe — CNES

Hoblos, Ghaleb — IRSEEM/ESIGELEC
Weber, Philippe — University of Lorraine

Rolling Element Bearings (REB) are one of the key components of rotating machinery. Their correct functioning and failure have been the object of many studies and today many models are available that can reproduce their vibration response. Most of them are applied for diagnosis purposes and simulate the bearing behaviour in steady state considering fixed surface defect. Such vibration signals are useful to perform bearing diagnosis but they lack the necessary information for predictive algorithms conceived for prognosis applications. The objective of the work presented here is using an already existing dynamic model to simulate vibration signals under unsteady degradation conditions. Different degradation profiles have been proposed to simulate the evolution of local surface defects on the bearing components to form a synthetic database for future prognosis applications. The obtained signals can be very useful for data-drive prognosis algorithm training. As proof, they were used for RUL (Remaining Useful Life) estimation with a simple approach and proved to be effective.

12:10-12:30 — TuA2.6

Unsupervised Anomaly Detection for Multivariate Incomplete Data Using GAN-Based Data Imputation: A Comparative Study, pp. 61-68

Sarda, Kisan — University of Sannio
Yerudkar, Amol — Zhejiang Normal University
Del Vecchio, Carmen — University of Sannio

With the increasing interconnectivity of cyber-physical systems (CPSs) in various fields, such as manufacturing plants, power plants, and smart networked systems, large amounts of multivariate data are generated through sensors and actuators, also other data sources such as measurements and images. This paper focuses on the anomaly detection (AD) problem, also known as fault detection or outlier detection, depending on the type of dataset, which involves identifying anomalous values in datasets using analytical methods. However, datasets often contain missing values, which can lead to incorrect outcomes and affect the availability of anomalous samples that are fewer in amount, making incomplete datasets. Therefore, a generalized AD method is proposed for incomplete datasets, which involves two steps: data imputation (DI) to obtain complete datasets using GAN and later AD for the complete datasets. While statistical-based imputation methods are commonly used, they do not consider data distribution for datasets with anomalous samples. The capabilities of GAN-based DI are tested under different hyperparameter settings and percentages of missing values. The AD problem is then addressed using seven unsupervised anomaly detection methods on six different datasets, including a real dataset from a steel manufacturing plant in Italy. Each dataset is analyzed to determine which DI and AD method combination performs the best. The results show that GAN-imputed data provides the best DI performance, while the reweighted minimum covariance determinant (RMCD) method offers the overall best AD results combined with GAN.

TuA3 — Grand Hall C
Energy Management and Sustainability (Regular Session)

Chair: Leva, Alberto — Politecnico Di Milano
Co-Chair: Eliades, Demetrios — University of Cyprus

10:30-10:50 — TuA3.1

Stochastic Thermodynamics: Dissipativity, Losslessness, Accumulativity, Energy Storage, and Entropy Production, pp. 69-74

Lanchares, Manuel — Georgia Institute of Technology
Haddad, Wassim M. — Georgia Institute of Technology

In this paper, we develop an energy-based dynamical system model driven by a Markov input process to present a unified framework for stochastic thermodynamics predicated on a stochastic dynamical systems formalism. Specifically, using a stochastic dissipativity, losslessness, and accumulativity theory, we develop a nonlinear stochastic port-Hamiltonian system model characterized by energy conservation and entropy nonconservation laws that are consistent with statistical thermodynamic principles. In particular, we show that the difference between the stored system energy and the supplied system energy for our stochastic thermodynamic model is a martingale with respect to the system filtration, whereas the system entropy is a submartingale with respect to the system filtration.

10:50-11:10 — TuA3.2

Efficient Control-Oriented Modelling of Heterogeneous Large-Scale Computer Cooling Systems, pp. 75-80

Leva, Alberto — Politecnico Di Milano
Terraneo, Federico — Politecnico Di Milano
Fornaciari, William — Politecnico Di Milano

The power of modern computing equipment, from small devices such as laptops through a variety of cases up to entire data centres, makes cooling vital. Especially in large-scale systems, delivering the right cooling to the right place at the right time is crucial for both computing performance and energy efficiency. As such, modern cooling systems require a lot of controls. Given the many cases to face, designing and assessing such controls requires tools to rapidly and modularly build and manage computationally efficient simulation models, sometimes concentrating on the thermal policies aboard on a chip, sometimes on the cooling of a rack, sometimes on an entire date centre with its fluid conditioning and transport machinery, and so forth. Though technology exist to address many such cases individually, a holistic approach to embrace them all within a unified modelling methodology and workflow is still the subject of research. In this paper we distil our experience over the last years, and discuss how a solution based on joining purpose-specific chip modelling (using the 3D-ICE simulator) and Equation-Based Object-Oriented Modelling (employing the Modelica language) can help the joint design of a computing system and its cooling.

11:10-11:30 — TuA3.3

An Interlaced Co-Estimation Technique for Batteries, pp. 81-86

Mostacciuolo, Elisa — University of Sannio
Iannelli, Luigi — University of Sannio

Baccari, Silvio — University of Campania
Vasca, Francesco — University of Sannio

The problem of simultaneous online co-estimation of the battery state of charge (SOC) and the parameters of the open circuit voltage (OCV) vs. SOC characteristic is investigated. It is shown that any co-estimation technique requires at least one known point in the function that approximates the OCV vs. SOC map. A co-estimation strategy based on the equivalent circuit model of the battery is then proposed and its well-posedness is analyzed. The technique is validated on real data coming from an automotive application.

11:30-11:50 TuA3.4

Ontology-Based Reasoning to Reconfigure Industrial Processes for Energy Efficiency, pp. 87-92

Kouzapas, Dimitrios — University of Cyprus
Stylianidis, Nearchos — University of Cyprus
Panayiotou, Christos — University of Cyprus
Eliades, Demetrios — University of Cyprus

Modern factories collect and process a large volume of different types of industrial process data. These data are used to develop metrics and Key Performance Indicators to monitor and improve productivity and the efficiency of a factory. This work develops an ontology-based framework that semantically describes an industrial process, and in particular it describes the elements of physical connectivity, industrial behaviour, and KPIs. Using a notion of sub-process hierarchy, a Decision Support System %based on the proposed framework explores and suggests options for reconfiguring the elements of the industrial process, to improve efficiency. A proof-of-concept use-case from the KIOS Water System Testbed is presented. The pumping station (connectivity, behaviour and energy efficiency KPIs) of the Testbed is semantically modelled, whereas the DSS suggests reconfiguration options for improving its overall energy efficiency.

11:50-12:10 TuA3.5

The Contribution of Semi-Transparent Photovoltaics for Energy Autonomy in Aloe Vera Greenhouse Cultivation, pp. 93-96

Kavga, Angeliki — University of Patras
Thomopoulos, Vasileios — University of Patras
Petrakis, Theodoros — University of Patras

Greenhouse systems offer a promising solution for meeting the growing demand for food production, especially during off-season crops, without compromising the quality and quantity of the products. However, the significant amount of energy consumption in greenhouses, including heating, cooling, and lighting, should not be ignored, as it contributes up to half of the production cost. Given the adverse impact of fossil fuels on climate change and the wider political, social, and economic context of the agricultural sector, it is essential to prioritize the use of renewable energy sources like solar energy. Unfortunately, the need for more land remains a major issue, causing spatial and economic challenges. Thus, a promising solution is to install semi-transparent photovoltaics on the roof of greenhouse units, creating dual use of land for both food and energy production. This paper aims to present the Greenhouse Integrated Photovoltaic System (GIPV) using the above elements for complete energy autonomy, focusing on Aloe Vera production.

12:10-12:30 TuA3.6

Nonlinear MPC for Fuel Cell Air Path Control with Experimental Validation, pp. 97-102

Schmitt, Lukas — RWTH Aachen University
Abel, Dirk — RWTH Aachen University

Fuel cell systems are a viable alternative for stationary and mobile applications. Advanced control algorithms are the main levers to ensure safe operation in transients and increase the applicability of fuel cell systems in research and industry. This paper focuses on the control of the fuel cell air path and the net power output for a small-scale fuel cell system. For safe operation and durability even in transients, tight bounds on stoichiometry and compressor operation must be ensured at all times. To tackle this challenge, a data-based nonlinear model predictive controller is implemented and experimentally validated on a cathode path test bench with a real-time fuel cell stack simulation. Our results show accurate tracking, safe operation, and a reduction in settling time to new power reference set points of approximately 50% compared to a reference controller.

TuA4 — Tefkros

Autonomous Vehicles (I) (Regular Session)

Chair: Votis, Konstantinos — Center for Research and Technology - Hellas
Co-Chair: Tsourveloudis, Nikos — Technical University of Crete

10:30-10:50 TuA4.1

Bibliometric Analysis on Applications of Digital Twins in Autonomous Vehicles, pp. 103-108

Sarantinoudis, Nikolaos — Technical University of Crete
Tsinarakis, George — Technical University of Crete
Doitsidis, Lefteris — Technical University of Crete
Tsourveloudis, Nikos — Technical University of Crete
Arampatzis, George — Technical University of Crete

This paper presents a bibliometric analysis of the research literature on potential applications of digital twins in autonomous vehicles, aiming to identify its main features, the current research trends and their evolution and potential gaps for future studies. The set of publications under study is collected through the most popular scientific databases by performing targeted queries and after removing erroneous entries. Different types of analysis (trend analysis, co-occurrence analysis and citation analysis) are performed and the results obtained are presented through graphs and tables, discussed to extract useful conclusions and widened to propose future extensions and suggestions for the involved stakeholders.

10:50-11:10 TuA4.2

EVENT: Real Time Video Feed Anomaly Detection for Enhanced Security in Autonomous Vehicles, pp. 109-114

Aivatoglou, Georgios	Center for Research and Technology - Hellas
Oikonomou, Nikolaos	Center for Research and Technology - Hellas
Spanos, Georgios	Center for Research and Technology - Hellas
Livitckaia, Kristina	Center for Research and Technology - Hellas
Votis, Konstantinos	Center for Research and Technology - Hellas
Tzovaras, Dimitrios	Center for Research and Technology - Hellas

Autonomous Vehicles have long leveraged Artificial Intelligence to be capable of self-driving without the need for a human supervisor. To achieve self-driving autonomy, various sensors are installed onboard the vehicle in order to be able to perceive information from its surroundings. However, since autonomous vehicles' capabilities rely heavily on sensor readings, various challenges arise in terms of security and privacy. Thus, it is of the essence to design methodologies able to detect anomalies caused by malicious threat actors or sensor malfunctions. This paper proposes an anomaly detection algorithm for autonomous vehicle camera sensors. By utilizing Recurrent Neural Networks in combination with Convolution operations, it is possible to obtain a sequence of images and reconstruct the next frame in real-time. By leveraging image similarity techniques such as Mean Squared Error and Structural Similarity Index, it is possible to compare the ground truth with the predicted image and draw conclusions about whether an anomaly is present. The experiments in real datasets captured from autonomous vehicles within the European-funded nIoVe project highlighted that the proposed framework is able to detect anomalies and malfunctions with high accuracy, clearly indicating the necessity of such algorithms to enhance the security of autonomous vehicles.

11:10-11:30 TuA4.3

Reviewing Deep Learning-Based Feature Extractors in a Novel Automotive SLAM Framework, pp. 115-120

Anagnostopoulos, Christos	Industrial Systems Institute / Athena Research Center
Lalos, Aris	Athena Research Center
Stylios, Chrysostomos	Athena Research Center
Petros Kapsalas, Petros	Panasonic Automotive Systems Europe
Nguyen, Duong-Van	Panasonic Automotive Systems Europe

Simultaneous Localization and Mapping (SLAM), which is characterized as a core problem in autonomous vehicles, involves the estimation of the vehicle's position and the concurrent building of the map of the environment. The use of deep learning-based feature extractors has gain increasing popularity since they possess the ability to extract reliable and repeatable features from raw sensor data. However, the performance of deep learning-based approaches varies depending on the application, environmental conditions, and the type of implemented technology. In this paper, we evaluate the performance of several deep learning-based feature extractors integrated into a SLAM system, using real and synthetic data as input, which implement common odometry problems. To our knowledge, this is the first work that benchmarks the accuracy of deep-learning based algorithms in estimating the vehicle's trajectory in specific odometry corner cases.

11:30-11:50 TuA4.4

Road Profile Estimation from Onboard Sensor Measurements through a Combination of H-Infinity and Unknown Inputs Observers, pp. 121-126

Bel Haj Frej, Ghazi	University of Bordeaux
Moreau, Xavier	University of Bordeaux
Guridis, Ramon	STELLANTIS
Benine-Neto, André	University of Bordeaux
Hernette, Vincent	Groupe PSA

Connected vehicles have introduced a vast array of possibilities to improve vehicle fleet performance. Vehicle-to-Vehicle (V2V) and vehicle-to-network (V2N) interactions allow collecting and communicating data on the vehicle's environment, traffic and safety. Sharing information on the road profile can ensure a safer mobility. In such framework, the goal of the paper is to explore the already existing sensors of the DS7 Crossback suspension system in order to estimate the road profile through a structure of Luenberger and unknown inputs observers. The unmeasured variables are estimated by resolving a linear matrix inequality (LMI) satisfying a H-Infinity criterion to reject external disturbances. The unknown input observer is provided by the sensor measurements enhanced by the estimated variables obtained from the Luenberger observer. Linear matrix inequality (LMI) tool is used for design observer gain and thus estimate the unknown road profile. Simulations are performed to show that the proposed structure successfully estimates the unknown road profile even in the presence of disturbances.

11:50-12:10 TuA4.5

Cybersecurity Oriented Architecture to Ensure the Autonomous Vehicles Communication, pp. 127-132

Sersemis, Athanasios	Center for Research and Technology - Hellas
Alexandros, Papadopoulos	Center for Research and Technology - Hellas
Spanos, Georgios	Center for Research and Technology - Hellas
Lalas, Antonios	Center for Research and Technology - Hellas
Votis, Konstantinos	Center for Research and Technology - Hellas
Tzovaras, Dimitrios	Center for Research and Technology - Hellas

The topic of in-vehicle and V2X communication in autonomous vehicles consists of a variety of different communication protocols, mechanisms, and devices. The implementation and cooperation between these entities and protocols in such a complex system is a rigorous and complicated process that should not only be efficient, robust, flexible, and scalable, but also secure. The security of critical systems such as autonomous vehicles requires a deep understanding of all the individual and distinct components that compose the system. This paper presents a cybersecurity architecture having as purpose to shield the communication security in the autonomous

vehicles. For this reason, several well-established cybersecurity tools (e.g. Keycloak, Cloudflare) and communication mechanisms (e.g. MQTT, Kafka) have been combined in this architecture along with a novel statistical-based Intrusion Detection System. All the aforementioned cybersecurity defense mechanisms were selected to protect the entire system pipeline and meet the requirements for Confidentiality, Integrity, and Availability regarding vehicle communication. To test the performance of the proposed architecture abnormal data have been injected to the system and the results from the experiments conducted highlighted that the proposed solution can achieve its purpose of increased cybersecurity.

TuA5	Evagoras
Image Processing (Regular Session)	
Chair: Gasparri, Andrea	Università Degli Studi Roma Tre
Co-Chair: Itami, Taku	Aoyamagakuin University

10:30-10:50 TuA5.1

Autonomous Mobile Robot Equipped with a Monocular Camera and Cross-Line Laser That Can Measure Obstacle Distance in Real Time Independent of Brightness, pp. 133-138

Mitsuhashi, Hayato — Aoyama Gakuin University
Akamine, Souta — Aoyama Gakuin University
Itami, Taku — Aoyama Gakuin University
Yoneyama, Jun — Aoyama Gakuin University

In this paper, we propose an algorithm that can measure obstacle distances in real time independent of brightness. The proposed method acquires camera information from a robot equipped with a cross-line laser and a monocular camera, binarizes only the cross-line laser light data using YUV values as threshold values, and calculates the ratio of color and luminance, thereby improving the method to measure the linear distance to obstacles in real time even in bright environments. Experimental results confirm that the proposed method can accurately detect the distance to obstacles. It was also able to accurately calculate the distance to obstacles even when the measurement environment was bright (717 Lux).

10:50-11:10 TuA5.2

A ROS-Based Architecture for Object Detection and Relative Localization for a Mobile Robot with an Application to a Precision Farming Scenario, pp. 139-144

Arlotta, Andrea — Roma Tre University
Lippi, Martina — Roma Tre University
Gasparri, Andrea — Roma Tre University

Several factors may compromise the effectiveness of algorithms for relatively localizing specific objects in outdoor unstructured environments using robotic platforms, such as the complexity of the environment, and changes in lighting conditions. Consequently, methods that rely solely on instantaneous detection may not be reliable in such application scenarios. In this work, we propose an architecture that utilizes an RGB-D camera mounted on a mobile robot and combines a state-of-the-art detection system with a purposely designed tracking algorithm. Specifically, we employ the latest You Only Look Once (YOLO) version to detect and segment the target in the image. We extract relevant relative information of the robot with respect to the object, i.e., its position and the relative orientation, by exploiting the depth map. Finally, we design an Extended Kalman Filter to track this relative information while taking into account the robot kinematic model. We implement this architecture in the ROS middleware and validate it within a precision agriculture setting for trap monitoring in a pest detection system.

11:10-11:30 TuA5.3

CNN Based Real-Time Forest Fire Detection System for Low-Power Embedded Devices, pp. 145-151

Ye, Jianlin — University of Central Lancashire Cyprus Campus
Ioannou, Stelios — University of Central Lancashire Cyprus Campus
Nikolaou, Panagiota — University of Central Lancashire Cyprus Campus
Raspopoulos, Marios — University of Central Lancashire Cyprus Campus

This paper proposes a system architecture that uses deep learning image processing techniques to automatically identify forest fires in real-time using neural network models for small UAV applications. Considering the strict power and payload constraints of small UAVs, the proposed model runs on a compact, lightweight Raspberry Pi4B (RPi4B) and its performance is comparable to the state-of-the-art metrics (accuracy and real-time response) while achieving significant reduction in CPU usage and power consumption. The proposed YOLOv5 optimization approach used in this paper includes: 1) Replacing the backbone network to ShuffleNetV2, 2) Pruning the Head and Neck network following the backbone baseline, 3) Sparse training to implement the model-pruning method, 4) Fine-tuning of the pruned network to recover the detection accuracy and 5) Hardware acceleration by overclocking the RPi4B to improve the inference speed of the algorithm. Experimental results of the proposed forest fire detection system show that the proposed algorithm compared to the state-of-the-art that run on RPi single board computer, achieves 50% higher inference speed (9 FPS), reduction in CPU usage and temperature by 35% and 25% respectively and 10% reduced power consumption while the accuracy (92.5%) is only compromised by 2%. Finally, it is worth noting that the accuracy of the proposed algorithm is not affected by deviations in the bird-eye view angle.

11:30-11:50 TuA5.4

Fruity: A Multi-Modal Dataset for Fruit Recognition and 6D-Pose Estimation in Precision Agriculture, pp. 152-157

Abdulsalam, Mahmoud — City, University of London
Chekakta, Zakaria — City, University of London
Aouf, Nabil — City, University of London
Hogan, Maxwell — City, University of London

The application of robotic platforms for precision agriculture is gaining traction in modern research. However, the demand for a complete fruit dataset is still not satisfied. In this paper, we present fruity, a multi-modal fruit dataset with a variety of use cases such as 6D-pose

estimation, fruit detection, fruit picking applications, etc. To the best of our knowledge, this dataset is the first-ever multi-modal fruit dataset tailored specifically for fruit 6D pose estimation in precision agriculture. The dataset is collected over a range of multiple sensors consisting of an RGB-D camera, thermal camera and an indoor tracking camera for ground truth poses. Fruity features RGB images, stereo depth images, thermal images, camera 6D- poses, fruit 6D-poses and relative 6D-poses between the cameras and fruits. The classes of the dataset are commonly harvested fruits which include: apples, oranges, bananas, avocados and lemons. It is also enriched with a clustered class to account for occlusion scenario. The dataset is recorded over multiple trajectories implemented with multiple platforms encompassing a robotic manipulator and an Unmanned Aerial Vehicle (UAV). The dataset alongside the documentation and utility tools is publicly available at: https://github.com/MahmoudYidi/Fruity.git.

11:50-12:10 TuA5.5

Image Based Model Predictive Controller for Autonomous Driving, pp. 158-165

Athni Hiremath, Sandesh — Rhineland-Palatinate Technical University Kaiserslautern-Landau
Gummadi, Praveen — Rhineland-Palatinate Technical University Kaiserslautern-Landau
Bajcinca, Naim — Rhineland-Palatinate Technical University Kaiserslautern-Landau

With cameras being one of the most vital sensors for perception and planning it is more intuitive to design controllers that are able to operate directly on the camera data. In this work we present two approaches for designing a model predictive controller (MPC) that is able to directly operate in the perspective coordinates and show their equivalence to the standard MPC formulation. Consequently, it eliminates the need for dedicated modules for converting the output of the planner and estimating the state of system in the 3D coordinates, thereby enabling a lean design of the system architecture. We apply this method for the task of automated lane following and lane changing, a common use case arising in autonomous driving, and demonstrate its effectiveness.

TuB1 — Grand Hall A

Autonomous Systems (Regular Session)

Chair: Kyriakopoulos, Kostas J. — National Tech. Univ. of Athens
Co-Chair: Wickers, Aaron — Helmut Schmidt Universität / University of the Federal Armed Forces Hamburg

14:00-14:20 TuB1.1

A Nonlinear Model Predictive Control Strategy for Water Sampling Using a UAV with a Slung Mechanism, pp. 166-171

Panetsos, Fotis — National Technical University of Athens
Karras, George — University of Thessaly
Kyriakopoulos, Kostas J. — National Technical University of Athens
Oikonomides, Odysseas — University of Cyprus
Kolios, Panayiotis — University of Cyprus
Eliades, Demetrios — University of Cyprus
Panayiotou, Christos — University of Cyprus

In this work, a nonlinear Model Predictive Control (NMPC) strategy is presented for stabilizing an Unmanned Aerial Vehicle (UAV) with a cable-suspended liquid collection device during water sampling from aquatic environments. Building upon our previous work, an NMPC scheme is developed which incorporates the disturbances acting on the multirotor and attains the accurate hovering of the vehicle while simultaneously state and input constraints are satisfied. Once the UAV is stabilized above the water surface, a custom electromechanical mechanism is activated to collect water samples. The performance of the proposed controller and the reliability of the sampling device are demonstrated through real-world experiments in a river with high water flow.

14:20-14:40 TuB1.2

Distributed Control for 3D Inspection Using Multi-UAV Systems, pp. 172-177

Zacharia, Angelos — University of Cyprus
Papaioannou, Savvas — University of Cyprus
Kolios, Panayiotis — University of Cyprus
Panayiotou, Christos — University of Cyprus

Cooperative control of multi-UAV systems has attracted substantial research attention due to its significance in various application sectors such as emergency response, search and rescue missions, and critical infrastructure inspection. This paper proposes a distributed control algorithm to generate collision-free trajectories that drive the multi-UAV system to completely inspect a set of 3D points on the surface of an object of interest. The objective of the UAVs is to cooperatively inspect the object of interest in the minimum amount of time. Extensive numerical simulations for a team of quadrotor UAVs inspecting a real 3D structure illustrate the validity and effectiveness of the proposed approach.

14:40-15:00 TuB1.3

Maximum Correntropy Criterion Kalman Filter for Indoor Quadrotor Navigation under Intermittent Measurements, pp. 178-183

Hadjiloizou, Loizos — KTH Royal Institute of Technology
Makridis, Evagoras — University of Cyprus
Charalambous, Themistoklis — University of Cyprus
Deliparaschos, Kyriakos — Cranfield University

We present a multisensor fusion framework for the onboard real-time navigation of a quadrotor in an indoor environment. The framework integrates sensor readings from an Inertial Measurement Unit (IMU), a camera-based object detection algorithm, and an Ultra-WideBand (UWB) localisation system. Often the sensor readings are not always readily available, leading to inaccurate pose estimation and hence poor navigation performance. To effectively handle and fuse sensor readings, and accurately estimate the pose of the quadrotor for

tracking a predefined trajectory, we design a Maximum Correntropy Criterion Kalman Filter (MCC-KF) that can manage intermittent observations. The MCC-KF is designed to improve the performance of the estimation process when is done with a Kalman Filter (KF), since KFs are likely to degrade dramatically in practical scenarios in which noise is non-Gaussian (especially when the noise is heavy-tailed). To evaluate the performance of the MCC-KF, we compare it with a previously designed Kalman filter by the authors. Through this comparison, we aim to demonstrate the effectiveness of the MCC-KF in handling indoor navigation missions. The simulation results show that our presented framework offers low positioning errors, while effectively handling intermittent sensor measurements.

15:00-15:20 TuB1.4

Joint Estimation and Control for Multi-Target Passive Monitoring with an Autonomous UAV Agent, pp. 184-189

Papaioannou, Savvas — University of Cyprus
Laoudias, Christos — University of Cyprus
Kolios, Panayiotis — University of Cyprus
Theocharides, Theocharis — University of Cyprus
Panayiotou, Christos — University of Cyprus

This work considers the problem of passively monitoring multiple moving targets with a single unmanned aerial vehicle (UAV) agent equipped with a direction-finding radar. This is in general a challenging problem due to the unobservability of the target states, and the highly non-linear measurement process. In addition to these challenges, in this work we also consider: a) environments with multiple obstacles where the targets need to be tracked as they manoeuvre through the obstacles, and b) multiple false-alarm measurements caused by the cluttered environment. To address these challenges we first design a model predictive guidance controller which is used to plan hypothetical target trajectories over a rolling finite planning horizon. We then formulate a joint estimation and control problem where the trajectory of the UAV agent is optimized to achieve optimal multi-target monitoring.

15:20-15:40 TuB1.5

Absolute Localization of an ROV in a Fish Pen Using Laser Triangulation, pp. 190-196

Bjerkeng, Magnus — SINTEF Digital
Grøtli, Esten Ingar — SINTEF Digital
Kirkhus, Trine — Sintef Digital
Jens, Thielemann — Sintef Digital
Amundsen, Herman Biørn — Norwegian University of Science and Technology
Su, Biao — SINTEF Ocean
Ohrem, Sveinung Johan — SINTEF Ocean

This paper proposes a low-cost solution for localizing a remotely operated vehicle (ROV) inside a fish net pen. The solution consists of a kinematic Kalman Filter capable of estimating the absolute ROV position and orientation in a fish net pen using primarily the onboard compass, laser-camera triangulation, and a model of the cylindrical net pen. The solution is demonstrated in a real fish net pen, under realistic operating conditions, and the performance is comparable to that of specialized positioning sensor systems such as ultra short baseline systems and Doppler velocity loggers.

15:40-16:00 TuB1.6

Comparison of Trajectory Tracking Flight Controllers in Position and Heading for Multicopter, pp. 197-203

Wickers, Aaron — Helmut Schmidt University
Schulzke, Alexander — Helmut Schmidt University
Myschik, Stephan — University of the Bundeswehr Munich
Alpen, Mirco — Helmut Schmidt University
Horn, Joachim — Helmut Schmidt University

This paper presents a comparison of three different control approaches for UAS flight controllers. A cascaded PID structure from Pixhawk, an energy-based controller and an incremental nonlinear dynamic inversion approach are implemented in a simulation environment based on MATLAB. The precision in position and heading angle, the required flight and calculation time and the effort to implement the algorithms are taken into account. Further, the results are evaluated for the specific UAS use cases of an infrastructure inspection and the drop-off of a sensor.

TuB2 — Grand Hall B

Fault Tolerant Control (Regular Session)

Chair: Witczak, Marcin — University of Zielona Gora
Co-Chair: Henry, David — Universite Bordeaux

14:00-14:20 TuB2.1

Optimal Trajectory Generation for Recovery of Quad-Plane UAVs with Complete Rotor Loss in Hover Flight, pp. 204-209

Strampe, Tilman — Technical University Darmstadt

We propose the design of an optimal control problem (OCP) for generating recovery trajectories to a safe set in the state space in case of an actuator failure. The OCP is developed for recovery of hybrid quad-plane unmanned aerial vehicles (UAV) with a complete rotor loss in the hover flight regime. The UAV is recovered to the safe fixed-wing flight while minimizing the loss of altitude. For solving the optimization problem sequential convex programming is used in order to turn infeasible initial guesses into feasible trajectories with respect to the dynamics and constraints. The applicability of the proposed method is shown with numerical results where recovery from various initial attitudes is demonstrated.

14:20-14:40 TuB2.2

An Output-Feedback Fault-Tolerant Control Approach for Multiple Faults, pp. 210-215

Pazera, Marcin	University of Zielona Gora
Witczak, Marcin	University of Zielona Gora
Puig, Vicenç	Universitat Politècnica De Catalunya (UPC)
Aubrun, Christophe	University of Lorraine

This paper proposes an output-feedback fault-tolerant control approach for multiple faults. The proposed approach is able to deal with both sensors and actuator faults. Moreover, the disturbances are assumed to be bounded within an ellipsoidal sets. The proposed strategy boils down to solving a set of LMIs along with an auxiliary parameter, which determines the convergence rate of the approach. Finally, the proposed strategy is illustrated with two-rotor aerodynamical system.

14:40-15:00 TuB2.3

Fault Tolerant Control Using Sliding Modes for Scale Model of a High Altitude Long Endurance Aircraft, pp. 216-221

Rawikara, Seno Sahisnu	University of Exeter
Alwi, Halim	University of Exeter
Edwards, Christopher	University of Exeter

This paper presents a fault-tolerant control scheme for a scale model of a High-Altitude Long Endurance UAV. The aircraft considered in this paper is a scale model glider that has a similar configuration to typical HALE platforms. The proposed control system was designed using sliding mode and control allocation to handle actuator faults. To evaluate the performance of the system, simulations were conducted using a nonlinear fixed-aerodynamic model. The results are promising, since the control system was able to handle multiple actuator failure cases, including a total actuator failure in the left surfaces.

15:00-15:20 TuB2.4

An Integral--Based Control Allocation Algorithm for Optimal Spacecraft Actuator Selection under L1, L2, Linfinity Criteria for Fault Tolerance, pp. 222-228

Henry, David	University of Bordeaux

This paper deals with fault tolerant control for space missions. A new integral--based control allocation algorithm is developed, for optimal spacecraft actuator selection. The algorithm is developed in a general manner so that the allocation can be done under l1,l2,linfinity optimisation criteria. Stability and convergence properties of the algorithm are formally proved, using the small gain theory and the scaled bounded real lemma. The proposed solution is evaluated through intensive simulations from a functional engineering simulator that accurately simulates an in-orbit autonomous rendezvous, on a circular orbit. The obtained results demonstrate the efficiency of the proposed fault-tolerant control allocation algorithm.

15:20-15:40 TuB2.5

Fault Tolerant Control of Hexarotor UAVs against Motor Failure, pp. 229-234

Liao, Fang	National University of Singapore
Zhao, Zuoquan	The Chinese University of Hong Kong
Wang, Jianliang	Hangzhou Innovation Institute of Beihang University

This paper proposes a new approach for fault tolerant control of hexarotor UAVs against motor failure subject to maximum motor speed constraint. The proposed approach consists of two parts: sliding mode control and dynamic control allocation. The sliding mode control is designed to generate the desired forces and torques that achieve and maintain flight stability and performance. As the control design is independent of plant model parameters, it remains the same across the cases of fault-free and motor failure. The dynamic control allocation is then applied to redistribute the desired forces and moments among the remaining healthy motors subject to maximum motor speed constraint. In the proposed approach, the control allocation problem is formulated in terms of solving a nonlinear optimization problem. Then the optimization problem is transformed to a stability problem where the convergence is established by using the Lyapunov stability theory. The simulation on a hexarotor UAV demonstrates the effectiveness of the proposed approach and the advantages over existing approach in terms of motor speed limits.

15:40-16:00 TuB2.6

Adaptive Backstepping Sliding Mode Based Fault-Tolerant Cooperative Control for Multiple UAVs under Thrust Loss Faults and Input Saturation, pp. 235-240

Yang, Zhongyu	Nanjing University of Aeronautics and Astronautics
Yu, Ziquan	Nanjing University of Aeronautics and Astronautics
Cheng, Yuehua	Nanjing University of Aeronautics and Astronautics
Xu, Guili	Nanjing University of Aeronautics and Astronautics
Zhang, Youmin	Concordia University

To overcome input saturation and loss of thrust effectiveness problems for multiple fixed-wing unmanned aerial vehicles (UAVs), a fault-tolerant cooperative control (FTCC) based on adaptive backstepping sliding mode control (BSMC) method is developed. An auxiliary dynamic system is constructed to solve the input saturation problem. Furthermore, adaptive laws are proposed to estimate the thrust effectiveness and lumped unknown term. Stability of the system and finite-time convergence of the error signals are proved by Lyapunov analysis. Finally, the effectiveness of the proposed control scheme is verified by the simulations.

TuB3 Grand Hall C

Power Systems and Smart Grid (Regular Session)

Chair: Boem, Francesca	University College London
Co-Chair: Konstantopoulos, George	University of Patras

14:00-14:20 TuB3.1

Resilient Distributed Integral Control for Multimachine Power Systems with Inherent Input Constraint Satisfaction, pp.

241-246

Kavvathas, Theodoros — University of Patras
Konstantopoulos, George — University of Patras
Konstantinou, Charalambos — King Abdullah University of Science and Technology (KAUST)

In this paper, a novel distributed controller for multimachine power systems is proposed to guarantee grid frequency restoration and accurate real and reactive power sharing among the generator units, while maintaining the generator inputs (mechanical torque and field excitation voltage) within given bounds. The boundedness of the controller outputs (generator inputs) is rigorously proven using vector field theory. It is additionally shown that even if one generator input reaches its upper/lower limit, the remaining units can still accomplish the desired control tasks without modifying the controller structure or dynamics; hence introducing enhanced system resilience using the proposed approach. This has been accomplished for the first time in a unified control structure while using neighbour-to-neighbour communication, thus maintaining the distributed nature of the controller. An example of a 10-bus, 4-machine power system is simulated to verify the proposed controller performance under sudden changes of the load demand.

14:20-14:40 TuB3.2

Control of Isolated AC Microgrids with Constant Power Loads: A Set Invariance Approach, pp. 247-252

Michos, Grigoris — University of Sheffield
Konstantopoulos, George — University of Patras
Trodden, Paul — University of Sheffield
Kadirkamanathan, Visakan — University of Sheffield

This paper proposes a robust control scheme for isolated AC Microgrids, where each node is connected locally to a constant power load (CPL). Contrary to many approaches in the literature, we consider the explicit model of the inverter dynamics and separate the overall system into two parts; a nominal subsystem parametrized by a nominal load and an error subsystem describing the difference between the true and the nominal voltage, resulting from perturbations of the load demand. In the presented analysis, we investigate the non-linear structure of the CPL in order to analytically describe its geometric effect on the network dynamics. We exploit this information to propose mild conditions on the tuning parameters such that a positive invariant set for the error dynamics exists and the distance between the true and the nominal voltage trajectories is bounded at all times. We demonstrate the properties of the proposed control scheme in a simulated scenario.

14:40-15:00 TuB3.3

Position and Speed Observer for PMSM with Unknown Stator Resistance and Inductance, pp. 253-258

Matveev, Kirill — ITMO University
Bazylev, Dmitry — ITMO University
Dobriborsci, Dmitrii — Deggendorf Institute of Technology

In this paper, we consider the problem of flux, position and speed observer design for permanent magnet synchronous motors (PMSMs) with uncertain parameters. It is assumed that the only measured signals are stator currents and control voltages. The key feature of the proposed approach is that it requires the knowledge of only one structural parameter of PMSM model - the number of pole pairs. Thus, all electrical and mechanical parameters, namely, the stator resistance and inductance, constant flux from permanent magnets, motor inertia and viscous friction coefficient are assumed to be unknown. A new nonlinear parameterization of motor model is proposed that is resulted in the regression model of eleven unknown parameters including the stator resistance and inductance as well as two parameters involved in the state observer design. The dynamic regressor extension and mixing (DREM) estimator is used to provide good performance and fast estimation of unknown parameters which is more efficient than the standard gradient approach in the case of high-dimensional regression models. Simulation results carried out for a typical scenario of motor operation illustrate good performance of the designed observer and parameter estimators.

15:00-15:20 TuB3.4

DFIG Wind Turbine Novel Cascade Control Guaranteeing Sensorless Field Orientation and Stability, pp. 259-264

Papageorgiou, Panos — University of Patras
Bourdoulis, Michael — University of Patras
Alexandridis, Antonio — University of Patras

The most common techniques employed for the control of doubly-fed induction generator (DFIG) wind turbine systems are restricted to either the well-known field-orientation control (FOC) or the direct-power control (DPC), with each one of them, however, suffering in one way or another from distinctive drawbacks. Instead of these standard methods, in this paper, a novel and nonlinear model-based control approach is adopted, which is developed in view of the entire system structure and characteristics. The key novelties introduced by the proposed design are due to an innovative technique, defined as 3s-FOC, which is formulated to enable the implementation of a simple cascade-mode PI-based control scheme that i) achieves stator field orientation without the need for estimating the actual flux, ii) guarantees system stability while simultaneously provides a relaxation on the transient response, iii) improves the closed-loop system dynamic behavior by employing extra damping terms in the inner-loop current regulators. The stability and state convergence properties of the complete system is firmly ensured as it is verified by a rigorous analysis based on advanced Lyapunov-based methods and input-to-state stability (ISS) techniques. Finally, a thorough simulation is conducted, which firmly verifies the theoretical results and the superior controlled system dynamic performance.

15:20-15:40 TuB3.5

An Event-Triggered Dynamic Consensus-Based Adaptive Electric Vehicles Fast Charging Control in an Isolated Microgrid, pp. 265-270

Abdelhamid, Mohamed — Alexandria University
Abbasy, Nabil — Alexandria University
Abuelanien, Ahmed — Alexandria University

Latest standards for DC fast charging (DCFC) stations enable up to 900 kW of charging power per Electric Vehicle (EV). Unfortunately, for a limited-capacity isolated Microgrid (MG), this high amount of power may lead to MG instability. In this research, a fully distributed

event-triggered Dynamic Consensus (DNC) technique is proposed for controlling DCFC fast charging process. The proposed control determines a proper charging rate considering the estimated real-time sparse capacity of the MG. Meanwhile, a safety factor is used to account for the system losses, demand growth, and sparse capacity estimation error. Moreover, the admissible Communication (COM) delay effect is evaluated. The control scheme is validated using a MATLAB/Simulink model. Different case studies with different conditions were simulated. The simulated cases show success of the proposed control strategy to have successful fast vehicle charging under different operating conditions without loss of stability.

15:40-16:00 TuB3.6

An Online Learning Method for Microgrid Energy Management Control, pp. 271-276

Casagrande, Vittorio — University College London
Ferianc, Martin — University College London
Rodrigues, Miguel — University College London
Boem, Francesca — University College London

We propose a novel Model Predictive Control (MPC) scheme based on online-learning (OL) for microgrid energy management, where the control optimisation is embedded as the last layer of the neural network. The proposed MPC scheme deals with uncertainty on the load and renewable generation power profiles and on electricity prices, by employing the predictions provided by an online trained neural network in the optimisation problem. In order to adapt to possible changes in the environment the neural network is online trained based on continuously received data. The network hyperparameters are selected by performing a hyperparameter optimisation before the deployment of the controller, using a pretraining dataset. We show the effectiveness of the proposed method for microgrid energy management through extensive experiments on real microgrid datasets. Moreover, we show that the proposed algorithm has good transfer learning (TL) capabilities among different microgrids.

TuB4 — Tefkros

Autonomous Vehicles (II) (Regular Session)

Chair: Gasparri, Andrea — Università Degli Studi Roma Tre
Co-Chair: Alma, Marouane — CRAN, Université De Lorraine

14:00-14:20 TuB4.1

MSL3D: Pointcloud-Based Muck Pile Segmentation and Localization in Unknown SubT Environments, pp. 277-282

Valdes Saucedo, Mario Alberto — Luleå University of Technology
Kanellakis, Christoforos — Luleå University of Technology
Nikolakopoulos, George — Luleå University of Technology

This article presents MSL3D, a novel framework for pointcloud-based muck pile Segmentation and Localization in unknown Sub-Terranean (Sub-T) environments. The proposed framework is capable of progressively segmenting the muck piles and extracting their location in a global constructed point cloud map. MSL3D is structured in a two layer novel architecture that relies on the geometric properties of muck piles in underground tunnels, where the first layer extracts a Volume Of Interest (VOI) proposal area out of the registered point cloud and the second layer is refining the muck pile extraction of each VOI proposal in the global optimized point cloud map. This action is performed by using a first instance of VOI that is then refined by utilizing a progressive RANSAC in order to extract the ceilings, walls, and ground of the scene. Once the refined VOI is extracted, it is transmitted to the second layer, where it is converted to the world frame coordinates. In the sequel, a progressive morphological filter is applied, in order to segment ground and nonground points, followed by RANSAC once again to extract the remaining points corresponding to the right and left walls. In this approach, euclidean clustering is utilized to keep the cluster with the majority of points, which is assumed to belong to the muck pile. The efficacy of the proposed novel scheme was successfully and experimentally validated in real and large scale SubT environments by utilizing a custom-made UAV.

14:20-14:40 TuB4.2

A Swarm-Based Distributed Algorithm for Target Encirclement with Application to Monitoring Tasks in Precision Agriculture Scenarios, pp. 283-288

de Carolis, Giovanni — Roma Tre University
Williams, Ryan — Virginia Polytechnic Institute and State University
Gasparri, Andrea — Roma Tre University

This paper proposes a swarm-based approach for coordinating a multi-agent system (MAS) in a 3D environment to encircle a target for monitoring tasks in precision agriculture. Specifically, we are motivated by the objective of encircling large tree canopies in order to collaboratively gather information on tree health status. This goal is achieved by enhancing classical potential-based swarm design with a novel topology switching policy allowing the desired encirclement behavior to emerge. The resulting interaction protocol requires agents to utilize only local information, ensuring collision-free trajectories without restrictive assumptions on the undirected time-varying graph encoding the network topology. Numerical results are presented to demonstrate the effectiveness of the proposed approach.

14:40-15:00 TuB4.3

A Novel High-Interaction Honeypot Network for Internet of Vehicles, pp. 289-294

Anastasiadis, Mike — Centre for Research and Technology - Hellas
Moschou, Konstantinos — Centre for Research and Technology - Hellas
Livitckaia, Kristina — Centre for Research and Technology - Hellas
Votis, Konstantinos — Centre for Research and Technology - Hellas
Tzovaras, Dimitrios — Centre for Research and Technology - Hellas

Along with the evolution of communication technologies, cybersecurity has evolved, and so have its new directions and demands. There is a wide range of tools to detect, analyse, or protect systems from malicious activity. Yet, as new technologies are emerging and maturing, the need for particular domain solutions arises. This paper proposes a methodology for a honeypot network organisation

mimicking vital autonomous vehicle sensors inside the Internet of Vehicles (IoV) infrastructure, along with attack propagation patterns analysis based on the logs collected from the honeypots. The discovery of sequential patterns is based on Markov Chain models applied in the honeyfarm data. Further, these trained models are applied with graph-based algorithms to discover the interaction patterns between honeypots targeting the discovery of segments that were attacked in series. The intelligence produced from the analysis is used to rank and estimate the relative importance of the honeypots in their framework. The results of our study allowed us to identify common attacks on the IoV system, detect the geolocation of each attacker, and specify the usage of each honeypot node from the attacker's perspective.

15:00-15:20 TuB4.4

Performance Evaluation of Cruise-Controlled Vehicles on a Macroscopic Scale, pp. 295-300

Theodosis, Dionysios — Technical University of Crete
Karafyllis, Iasson — National Technical University of Athens
Titakis, George — Technical University of Crete
Papamichail, Ioannis — Technical University of Crete
Papageorgiou, Markos — Technical University of Crete

In this paper, we study the performance of a class of cruise-controllers for automated vehicles on a macroscopic scale. We first show that the solution of the corresponding second-order macroscopic model can be approximated by the solution of a nonlinear heat-type equation and introduce an appropriate notion of a weak solution that requires certain entropy-like conditions. To study the behavior induced on the macroscopic model by the first-order approximation, we derive a conservative finite-difference scheme that respects the corresponding entropy conditions. Certain links between the weak solution of the nonlinear heat equation and the solution produced by the proposed numerical scheme are also provided. Finally, a traffic simulation scenario and a comparison with the Lighthill-Witham-Richards (LWR) model are given, illustrating the benefits of the use of cruise-controlled vehicles.

15:20-15:40 TuB4.5

State Estimation of Longitudinal Vehicle Model Using $mathcal{H}_infty$ LMI-Based Nonlinear Observer, pp. 301-306

Mohite, Shivaraj — University of Lorraine
Alma, Marouane — University of Lorraine
Zemouche, Ali — University of Lorraine
Haddad, Madjid — SEGULA TECHNOLOGIES

Modern transportation research has given a lot of attention to autonomous vehicles. For the control of these vehicles, the longitudinal states of vehicle dynamics play a critical role. The objective of the article is to develop an LMI-based nonlinear observer which estimates the states of vehicles under the presence of disturbance. To achieve this, the observer proposed in~cite{Mohite_LMI} is extended by using the $mathcal{H}_infty$ criterion, and a new LMI condition is derived. Further, the proposed observer is implemented and validated on a third-order ``Position-Velocity-Acceleration" nonlinear autonomous vehicle model.

15:40-16:00 TuB4.6

Hierarchical Control in Skid Steer Mobile Robots with Nonholonomics Constraints, pp. 307-312

Ferreira, Anna Rafaela Silva — Pontifical Catholic University of Rio De Janeiro
Medeiros, Vivian Suzano — University of São Paulo
Hultmann Ayala, Helon Vicente — Pontifical Catholic University of Rio De Janeiro
Meggiolaro, Marco Antonio — Pontifical Catholic University of Rio De Janeiro

Skid-steered mobile robots are widely used in several applications due to their simple mechanical structure and their high maneuverability. This paper proposes a hierarchical control system for such robots that, at a high level, uses Nonlinear Model Predictive Control (NMPC) with a simplified prediction model, optimizing the longitudinal forces between the wheels and the ground to follow the desired trajectory. Using Pacekja's formula, the reference slip for each wheel is obtained by interpolation, allowing the computation of the reference angular speeds of the wheels. Then, a proportional control is employed to find the required wheel torques, which are applied to a complete model of the skid-steer robot that takes into account the longitudinal slippage on the wheels. The proposed hierarchical controller is compared with a purely NMPC approach using the full model of the robot and a classical proportional control. Double-lane change and a circular trajectory tracking was performed. The resulting torque variation is compatible with values obtained in physical systems and the wheel skidding remained within the allowed limit.

TuB5 Evagoras

Intelligent Data Processing in Control and Decision Support Systems (SENSYS 23) (Invited Session)

Chair: Popescu, Dan — University POLITEHNICA of Bucharest
Co-Chair: Ichim, Loretta — Politehnica University of Bucharest
Organizer: Popescu, Dan — University POLITEHNICA of Bucharest
Organizer: Lazar, Corneliu — Gheorghe Asachi Technical University of Iasi
Organizer: Ichim, Loretta — Politehnica University of Bucharest

14:00-14:20 TuB5.1

Privacy-Preserving Medical Image Classification through Deep Learning and Matrix Decomposition (I), pp. 313-318

Popescu, Andreea Bianca — Transilvania University of Brasov
Nita, Cosmin — Transilvania University of Brasov
Taca, Ioana Antonia — Transilvania University of Brasov
Vizitiu, Anamaria — Transilvania University of Brasov
Itu, Lucian — Transilvania University of Brasov

Deep learning (DL)-based solutions have been extensively researched in the medical domain in recent years, enhancing the efficacy of diagnosis, planning, and treatment. Since the usage of health-related data is strictly regulated, processing medical records outside the hospital environment for developing and using DL models demands robust data protection measures. At the same time, it can be challenging to guarantee that a DL solution delivers a minimum level of performance when being trained on secured data, without being specifically designed for the given task. Our approach uses singular value decomposition (SVD) and principal component analysis (PCA) to obfuscate the medical images before employing them in the DL analysis. The capability of DL algorithms to extract relevant information from secured data is assessed on a task of angiographic view classification based on obfuscated frames. The security level is probed by simulated artificial intelligence (AI)-based reconstruction attacks, considering two threat actors with different prior knowledge of the targeted data. The degree of privacy is quantitatively measured using similarity indices. Although a trade-off between privacy and accuracy should be considered, the proposed technique allows for training the angiographic view classifier exclusively on secured data with satisfactory performance and with no computational overhead, model adaptation, or hyperparameter tuning. While the obfuscated medical image content is well protected against human perception, the hypothetical reconstruction attack proved that it is also difficult to recover the complete information of the original frames.

14:20-14:40 TuB5.2

Deep Convolutional Neural Networks for Real-Time Human Detection and Tracking on UAVs Embedded Systems (I), pp. 319-324

Serghei, Trandafir-Liviu — Polytechnic University of Bucharest
Prvu, Petrisor — Polytechnic University of Bucharest
Simon, Madalina-Oana — Polytechnic University of Bucharest
Popescu, Dan — Polytechnic University of Bucharest
Ichim, Loretta — Polytechnic University of Bucharest

Human detection in critical missions with unmanned aerial vehicle (UAV) support gains nowadays more and more important in the actual context when tension at borders builds up for an increasing number of countries. Although convolutional neural networks are continuously evolving, the required computational resources pose a great problem when implemented on portable embedded systems such as UAVs, with limited processing power and autonomy. This demand becomes even more drastic when running real-time human detection. The paper proposes an improved implementation of the YOLO v7 network, trained on a custom dataset, for real-time human detection and tracking with confidence scores above 80% on the NVIDIA Jetson TX2 neural processing unit equipped on DJI Matrice 100 UAV. The authors created a YOLO v7 model running independently on an embedded system for real-time human detection and tracking.

14:40-15:00 TuB5.3

Deep Neural Networks for Halyomorpha Halys Detection (I), pp. 325-330

Dinca, Alexandru — Polytechnic University of Bucharest
Angelescu, Nicoleta — Valahia University of Targoviste
Ichim, Loretta — Polytechnic University of Bucharest
Popescu, Dan — Polytechnic University of Bucharest

Pest detection and identification in a timely manner is a crucial step for precision agriculture. Halyomorpha Halys is a common pest whose negative effects are known in agricultural areas and on various crops. The present work implemented and studied four performant neural networks, VGG19_BN, EfficientNetB7, DenseNet161, and ResNet152 for the detection of these insects. Although the detection of these insects in the natural environment through automated means, excluding traps, is a challenge, the results obtained are promising.

15:00-15:20 TuB5.4

Person Detection and Tracking Using UAV and Neural Networks (I), pp. 331-336

Stan, Anrei-Stelian — Polytechnic University of Bucharest
Ichim, Loretta — Polytechnic University of Bucharest
Prvu, Petrisor — Polytechnic University of Bucharest
Popescu, Dan — Polytechnic University of Bucharest

Since drone technology has recently advanced, human detection and tracking techniques have increased, and these technologies have a variety of uses, particularly close to borders. In this research, we examined methods to enhance people detection performance in diverse outdoor scenarios. A broad variety of light and color changes, as well as different target distances, angles, and postures, were all considered in the dataset's design. The experimental data were based on images taken under various environmental situations, like changing the drone's flight height, capturing pictures in low light, and so on. To calculate the metrics and useful performance indicators, this study proposes an enhanced version of the generic YOLOv5 model. This is accomplished by applying the data gathered to each model, including the baseline YOLOv5 model and the enhanced custom model. The main metrics are the improved YOLOv5 model loss functions, recall, accuracy, and mAP50. An evaluation was reached after contrasting the outcomes of the standard YOLOv5 model and the modified YOLOv5 model against the same testing set.

15:20-15:40 TuB5.5

Experimental Comparison of Two Data-Driven Algorithms for Pitch Control of an Aerospace System (I), pp. 337-342

Baciu, Andrei — Gheorghe Asachi Technical University of Iasi
Lazar, Corneliu — Gheorghe Asachi Technical University of Iasi

Data-driven control (DDC) algorithms have been developed in the last decades, whose design is based only on the data collected from the controlled plant, without using a process model. These techniques that do not use an explicit model of the system have become very attractive for the control of complex processes with high nonlinearities. This paper presents two DDC algorithms, one model-free adaptive control (MFAC), and the other model-free intelligent P (iP), whose performances are experimentally evaluated using the AERO 2 platform, a highly nonlinear aerospace system made by Quanser. The similarities and differences between the two DDC are succinctly presented and based on the results obtained through real-time experiments, the performances are compared.

15:40-16:00 TuB5.6

Study of Medical Image Traffic Using MPLS Technology (I), pp. 343-348

Stanescu, Cristian	Valahia University of Targoviste
Predusca, Gabriel	University Valahia of Targoviste
Angelescu, Nicoleta	Valahia University of Targoviste
Circiumarescu, Denisa	University Valahia of Targoviste
Puchianu, Dan Constantin	Valahia University of Targoviste
Hagiescu, Daniela	Advanced Slisys SRL

Multiprotocol Label Switching (MPLS)combines multiple advanced systems for embedding techniques like ATM and IP with Quality of Service (QoS). This paper investigates and provides solutions for implementing a local Label Switched Path (LSP) recovery mechanism. This mechanism allows for an alternative path to be set up when an accidental drop in the topology affects an LSP that carries a privileged data flow. The new path has equivalent properties to its predecessor, thus privileged traffic can be redirected. The analysis was performed on the traffic of medical image data.

TuC1	Grand Hall A
Navigation (Regular Session)	
Chair: Tzes, Anthony	New York University Abu Dhabi
Co-Chair: Khorrami, Farshad	NYU Tandon School of Engineering (polytechnic Institute)

16:30-16:50 TuC1.1

Precise Orbit Determination on LEO Satellite Using Pseudorange and Pseudorange-Rate Measurements, pp. 349-355

Tantucci, Andrea	Sapienza University of Rome
Wrona, Andrea	Sapienza University of Rome
Pietrabissa, Antonio	Consortium for the Research in Automation and Telecommunication

Nowadays, along with the trend of developing highly autonomous spacecrafts, there is a strong motivation to improve real-time Precise Orbit Determination (POD), in particular for Low Earth Orbit (LEO) satellites. The development of Global Navigation Satellite System (GNSS) sensors allows to obtain low-noise measurements and provide a spacecraft with autonomous continuous tracking onboard. Following the deactivation of Selective Availability, a representative real-time positioning accuracy of 10 m is presently achieved by means of Global Positioning System (GPS) receivers on LEO satellites. The introduction of dynamical filtering methods has opened a new way to improve this accuracy by making use of measurements such as pseudorange or carrier-phase. This paper presents a Kalman filtering approach using pseudorange and pseudorange-rate measurements instead of pseudorange and carrier-phase ones, with advantages in terms of storage and processing requirements. An error of around 0.2 m and 1e-3 m/s for position and velocity is obtained, which is in line if not better w.r.t. other approaches.

16:50-17:10 TuC1.2

Spline-Based Dynamic Object Handling in Autonomous Vehicles: A Model-Based Path Planning Algorithm, pp. 356-363

Stefanopoulou, Aliki	Democritus University of Thrace
Gkelios, Socratis	Democritus University of Thrace
Kapoutsis, Athanasios	Centre for Research and Technology - Hellas
Kosmatopoulos, Elias	Democritus University of Thrace
Boutalis, Yiannis	Democritus University of Thrace

In this study we propose a model-based dynamic path planning algorithm that is designed to navigate Autonomous Vehicles through complex and dynamic environments. To achieve that, a novel spline-based approach is utilized for the production of several candidate paths along a predetermined route and a Gaussian-based function is utilized for their evaluation. Our algorithm takes into account various factors, such as static and dynamic objects, to make the appropriate decisions for the vehicle's path, making it a promising solution for such objects during an autonomous vehicle navigation. The algorithm was tested in high-fidelity scenarios using CARLA Simulator, which is a powerful tool for simulating autonomous vehicle scenarios. The results indicate that the proposed algorithm is capable of generating efficient and safe paths for the vehicle to follow.

17:10-17:30 TuC1.3

Framework for Autonomous Navigation for a Permanent Resident Aquaculture Net Grooming Robot, pp. 364-371

Skaldebø, Martin	SINTEF Ocean
Ohrem, Sveinung Johan	SINTEF Ocean
Kelasidi, Eleni	SINTEF Ocean
Amundsen, Herman Biørn	Norwegian University of Science and Technology
Bloecher, Nina	SINTEF Ocean

This paper proposes methods to enable autonomous operation, specifically for localization and motion planning, of net grooming robots in aquaculture net pens and validates the proposed methods in both simulations and experimental fieldwork. Moreover, this paper suggests enabling uninterrupted operation by investigating the use of data from an inertial measurements unit that is a common sensor in underwater vehicles, rather than investing and upgrading to costly sensory systems that often require additional installation and calibration. In particular, the presented work consists of a localization method capable of estimating a robotic system's cylindrical position in an aquaculture net pen, a 3~DOF cylindrical robotic model, a method for path planning and collision avoidance, and a heading guidance and control system. The simulations demonstrate successful localization of the robotic system, while simultaneously planning and following collision-free trajectories in an environment obstructed by obstacles. Furthermore, the field trials successfully demonstrate that the system, when applied to net crawling robots, is capable of localization, path planning, and collision avoidance in an aquaculture setting. As follows, the presented work contributes to establishing net grooming robots as competitive candidates for biofouling management.

17:30-17:50 TuC1.4

Combined Aerial Cooperative Tethered Carrying and Path Planning for Quadrotors in Confined Environments, pp. 372-377

Stamatopoulos, Marios-Nektarios — Luleå University of Technology
Koustoumpardis, Panagiotis — University of Patras
Seisa, Achilleas Santi — Luleå University of Technology
Nikolakopoulos, George — Luleå University of Technology

In this article, a novel combined aerial cooperative tethered carrying and path planning framework is introduced with a special focus on applications in confined environments. The proposed work is aiming towards solving the path planning problem for the formation of two quadrotors, while having a rope hanging below them and passing through or around obstacles. A novel composition mechanism is proposed, which simplifies the degrees of freedom of the combined aerial system and expresses the corresponding states in a compact form. Given the state of the composition, a dynamic body is generated that encapsulates the quadrotors-rope system and makes the procedure of collision checking between the system and the environment more efficient. By utilizing the above two abstractions, an RRT path planning scheme is implemented and a collision-free path for the formation is generated. This path is decomposed back to the quadrotors' desired positions that are fed to the Model Predictive Controller (MPC) for each one. The efficiency of the proposed framework is experimentally evaluated.

17:50-18:10 TuC1.5

Enhancing LiDAR Point Cloud Segmentation with Synthetic Data, pp. 378-383

Inan, Burak Alp — City, University of London
Rondao, Duarte — City, University of London
Aouf, Nabil — City, University of London

LiDAR point-cloud segmentation is a crucial issue for autonomous cars applications. The standard method for segmenting large-scale point clouds is to project 3D point cloud onto a 2D LiDAR image and apply convolutions to it. In this paper, we also follow this method and we want to detect and classify occurrences of road-objects, namely cars, cyclists, and pedestrians. To achieve this goal, we adapted the SqueezeSeg deep neural network.To address the challenge of obtaining labeled data for training autonomous driving systems, we used the CARLA autonomous driving simulator to generate a synthetic dataset in a simulation environment. The proposed network is initially trained on real-world LiDAR point-cloud data acquired from the KITTI dataset. Then, we created a synthetic dataset using the CARLA autonomous driving simulator in order to obtain more data and determine its impact on the validation accuracy of real-world data. To compare our current work to earlier work, we employ the same method. Our synthetic dataset has additional classes, such as cyclists and pedestrians, and when combined with real-world data, it significantly improves validation accuracy for each class, surpassing previous work. This demonstrates the effectiveness of our approach in detecting and classifying road-objects using LiDAR point-clouds, which is essential for the safe operation of autonomous vehicles. Index Terms— Semantic Segmentation, LiDAR Point Cloud Segmentation, Spherical Projection, CARLA Simulator, CNN, Conditional Random Field

18:10-18:30 TuC1.6

Avoiding Undesirable Equilibria in Control Barrier Function Approaches for Multi-Robot Planar Systems, pp. 384-389

Vinicius, Goncalves — New York University
Krishnamurthy, Prashanth — New York University
Tzes, Anthony — New York University
Khorrami, Farshad — New York University

Control Barrier Functions (CBFs) when paired with Quadratic Programming offer an efficient way to generate safety-critical controllers. In this paper, we utilize CBFs for guiding multiple robots to their goals while avoiding collisions with the environment and among themselves. However, in more complex scenarios, with many robots and non-convex obstacles, these approaches often fail to guide the robots towards their desired goals because there can be other stable and undesirable equilibrium points in the system other than the desired one (reaching the goal). The proposed approach in this paper mitigates this issue by including constraints in the formulation that force the robots to circulate the boundary of the obstacles as well as each other when in close proximity. This ensures that the system does not get stuck in an undesirable equilibrium. Simulation studies show the efficacy of the proposed approach for a multi-agent problem.

TuC2 — Grand Hall B

Cyber-Physical Systems (Regular Session)

Chair: Zhang, Youmin — Concordia University
Co-Chair: Ellinas, Georgios — University of Cyprus

16:30-16:50 TuC2.1

Multirate Interlaced Kalman Filter, pp. 390-396

Bonagura, Valeria — Roma Tre University
Foglietta, Chiara — Roma Tre University
Panzieri, Stefano — Roma Tre University
Pascucci, Federica — Roma Tre University

Large systems are typically partitioned in many subsystems to reduce computational load. For this reason, the Interlaced Extended Kalman Filter (IEKF) was created, in which each subsystem estimates only its own state while utilizing information from other subsystems. The information shared is normally the a-priori and a-posteriori state, as well as the a-priori and a-posteriori covariance matrix.

Subsystems, however, cannot, for technological reasons, always operate at the same rate. To address this issue, we propose a multirate distributed filter, in which the subsystems operate independently and only share information when a novel measurement activates each

subsubsystem. The only information exchanged is the a-posteriori state and covariance matrix. In the paper, we demonstrate that the proposed filtering technique is accurate and effective by examining the convergence property. A water tank case study is detailed, and two subsubsystem with different but fixed rates are discussed, illustrating the efficiency of the proposed solution. The same approach can be modified to take into account numerous instances of subsubsystem as well as missing data due to an unreliable communication route.

16:50-17:10 TuC2.2

Robust Covert Attack Strategies and Their Detection for Switched Cyber-Physical Systems, pp. 397-402

Kazemi, MohamadGhasem — Concordia University
Khorasani, Khashayar — Concordia University

In this paper, first, a robust covert attack is designed for switched cyber-physical systems with synchronous switching from the attacker-viewpoint in which the attacker makes the system follow their specified reference signal while it remains stealthy in the monitoring system. This attack is defined in the form of H∞ control problem such that the objectives of the attacker will be achieved. Next, as a defender, a novel detection method will be presented that can detect covert attacks in the switched system. In the proposed method, we do not need any secure channel and even in the case that the attacker can find the model of the auxiliary system and injects another signal on the corresponding communicated information, the cyber-attack can be detected. The only protected information in the proposed method is the considered delay in the mode information of the auxiliary system that needs to be exactly estimated by the attacker to have a completely stealthy attack. Simulation results demonstrate and illustrate the significant performance and capabilities of the proposed method.

17:10-17:30 TuC2.3

DRIVERS: A Platform for Dynamic Risk Assessment of Emergent Cyber Threats for Industrial Control Systems, pp. 403-408

Nobili, Martina — University Campus Bio-Medico of Rome
Fioravanti, Camilla — University Campus Bio-Medico of Rome
Guarino, Simone — University Campus Bio-Medico of Rome
Ansaldi, Silvia Maria — Italian National Institute for Insurance against Accidents
Milazzo, Maria Francesca — University of Messina
Bragatto, Paolo — University Campus Bio-Medico of Rome
Setola, Roberto — University Campus Bio-Medico of Rome

A good cyber risk assessment is nowadays a matter of paramount importance for industrial systems and critical infrastructures. In a radical change and continuous development scenario such as that represented by Industry 4.0 plants, it is no longer sufficient to consider only static risks relating to the analysis of past data, but there is a need for a risk assessment that takes into account risks arising from emergent threats. In this paper, we propose a novel methodology for dynamic risk assessment that takes into account both the known values related to the static components of the system and the risks related to the emergence of new threats that have not yet been verified but are plausible according to experts. To achieve this, as part of the national "DRIVERS" project, an analysis of the most significant cyber-security factors was conducted to classify them in terms of relevance, considering both risk acceleration and risk mitigation aspects. This assessment is carried out by means of the multi-criteria decision support technique Analytic Hierarchy Process (AHP), performed by dividing the threat into a hierarchical structure.

17:30-17:50 TuC2.4

Event-Triggered Consensus Control of Multi-Agent System under Periodic DoS Attacks, pp. 409-414

Yang, Haichuan — Nanjing University of Aeronautics and Astronautics
Fu, Minrui — Nanjing University of Aeronautics and Astronautics
Yu, Ziquan — Nanjing University of Aeronautics and Astronautics
Zhang, Youmin — Concordia University

The consensus control problem for the multi-agent system (MAS) against periodic Denial-of-Service (DoS) attacks is focused on in this paper. The characteristic of periodic DoS attacks is that the attack duration is fixed, and the attack start time of each attack is periodic. Considering arbitrary periodic DoS attacks under a communication topology, a resilient controller with a switching mechanism is proposed by using the present and delayed neighbor information. Besides, an event-triggered mechanism (ETM) is designed to adjust the controller triggering frequency according to the periodic DoS attacks. The consensus and convergency of MAS against periodic DoS attacks are theoretically analyzed via Lyapunov stability criteria. Numerical simulations are provided to demonstrate the effectiveness of the proposed method.

17:50-18:10 TuC2.5

Robust Cooperative Sparse Representation Solutions for Detecting and Mitigating Spoofing Attacks in Autonomous Vehicles, pp. 415-420

Piperigkos, Nikos — University of Patras
Anagnostopoulos, Christos — Industrial Systems Institute / Athena Research Center
Lalos, Aris — Athena Research Center
Zukhraf, Syeda Zillay Nain — University of Cyprus
Laoudias, Christos — University of Cyprus
Michael, Maria K. — University of Cyprus

The new era of Industry 4.0 and its key-enabling Internet of Things technologies promises fundamental advances during data collection, processing and analysis from a variety of agents and sensors, for the collective benefit of society. In this regard, connected and autonomous vehicles equipped with integrated perception sensors and communication abilities formulate a cluster or swarm of intelligent nodes capable to transform the transportation sector into a new smart mobility system. However, its feasible operation may be potentially threatened by hijackers whose goal is to cause malfunctioning to critical vehicular sensors, harnessing the perception system of vehicle. Therefore, in this paper we discuss the impact of cyberattacks such as GPS spoofing on autonomous vehicles, and design efficient

detection and mitigation centralized schemes which provide location awareness and security monitoring over the whole cluster of vehicles. More specifically, we exploit the cooperation among the interacting vehicles, and develop robust sparse coding solutions based on graph signal processing and Alternating Direction Method of Multipliers. Cooperative based approach is further benefited by a in-vehicle module which provides spoofing detection alerts at the level of individual vehicle. Experimental analysis using the renowned CARLA simulator indicates highly efficient mitigation performance for different rates of compromised vehicles, as well as spoofing detection metrics greater than 94%.

18:10-18:30 TuC2.6

Wide Area Monitoring and Advisory Service for Smart Grids As a 5G-Enabled Network Application (I), pp. 421-423

Shangov, Daniel — Elektroenergien Sistemen Operator EAD
Ciornei, Irina — University of Cyprus
Hristov, Georgi — VivaCom
Velev, Valentin — Software Company
Antonopoulos, Angelos — Nearby Computing
Brodimas, Dimitrios — Independent Power Transmission
Ellinas, Georgios — University of Cyprus
Asprou, Markos — University of Cyprus
Rantopoulos, Michalis — Hellenic Telecommunications Organization S.A., OTE
Chochliouros, Ioannis — Hellenic Telecommunications Organization S.A., OTE

The smart grid era relies on the large deployment of advanced monitoring, automation and communication infrastructures. Features such as flexibility and scalability of digital services to sustain smart grid operation functions are core requirements for smart grids architectures. This work elaborates on the use of 5th generation wireless communication as key technology for enabling secure, scalable and flexible digital services for electric power and energy stakeholders. Specifically, this work introduces the Network Application concept defined by the Smart5Grid Project for rolling out such type of smart grid digital services. A concrete example in terms of development, implementation and testing of Wide Area Monitoring services as a 5G-enabled Network Application in a Hardware-In-the Loop testbed is also provided. The results of this integration and testing process demonstrate the viability of the proposed solution.

TuC3 Grand Hall C

Automotive Control (Regular Session)

Chair: El Hajjaji, Ahmed — Univ. De Picardie-Jules Verne
Co-Chair: Alma, Marouane — CRAN, Université De Lorraine

16:30-16:50 TuC3.1

RL-Based Path Planning for Controller Performance Validation, pp. 424-429

Schichler, Lukas — Virtual Vehicle Research GmbH
Tieber, Karin — Virtual Vehicle Research GmbH
Stolz, Michael — Virtual Vehicle Research GmbH
Watzenig, Daniel — Virtual Vehicle Research GmbH

Autonomous vehicles (AVs) will be part of everyday life in the near future. In order to accelerate this process, many subsystems need to be optimised and validated. One of the most important subsystem of AVs is the steering controller. It's task is to keep the vehicle on track, which is the reason, why many steering controllers have been designed for a large variety of applications. However, the validation of such controllers is a labour-intensive task, which is why in this paper, an Artificial Intelligence (AI) is trained to find an edge case path that brings the steering controller to its limits. This path is a sufficient substitute for a large set of paths and enables fast validation of steering controllers. This contribution describes the development of a reinforcement learning (RL) based path planner using the PPO-Algorithm to train a so called agent. Comparing the resulting key feature maps shows that the agent adapts to each controllers characteristics during the learning process. The result is demonstrated for three different state of the art path tracking controllers. For each controller the agent finds a path that leads to the controllers failure within seconds.

16:50-17:10 TuC3.2

Two-Level Steering Stability Control Based on Energy-Saving of a Four In-Wheel Motor Drive Electric Vehicle, pp. 430-435

Achdad, Reda — University of Picardie Jules Verne
Rabhi, Abdelhamid — University of Picardie Jules Verne
Pages, Olivier — University of Picardie Jules Verne
Bosche, Jerome — University of Picardie Jules Verne

In order to enhance the energy economy of a four independent wheel motor drive electric vehicle (4-IWMDEV), this paper proposes an optimal based energy-saving torque distribution. The proposed algorithm can adapt to different driving conditions while ensuring vehicle stability control. The controller consists of a hierarchical structure, a reference model which generates the desired vehicle dynamics parameters, and an upper-level control that computes the integrated traction force and yaw moment. The lower-level control employs a multi- objective optimization that considers energy efficiency and steer- ing stability to calculate the optimal torque distribution for each motor. The yaw moment control of 4-IWMDEV, integrated in the latest version of Carsim, with the classical tire workload control, were chosen to compare and evaluate the proposed controller. It has been shown from simulation studies, that vehicle steering stability and energy efficiency can be effectively improved.

17:10-17:30 TuC3.3

Observer-Based State Feedback Air Path Control for a Turbocharged Diesel Engine with EGR and VGT, pp. 436-441

Djadane, Oussama — University of Picardy Jules Verne

Makni, Salama — University of Picardy Jules Verne
El Hajjaji, Ahmed — University of Picardy Jules Verne

This paper is concerned with the VGT (Variable Geometry Turbocharger) and EGR (Exhaust Gas Recirculation) control design for the air path of a Diesel engine. The purpose is to validate a Diesel engine model by choosing the right operating conditions based on a series of open-loop tests. For the control design, an observer-based control with integrator is developed for the estimation of the compressor power and a good tracking of reference pressure signals which correspond to emission standards. The efficiency of this method is illustrated through simulation results on the Amesim software.

17:30-17:50 TuC3.4

L 1-Functional Interval Observers for Continuous-Time Linear Parameter-Varying Multivariable Systems, pp. 442-447

Mizouri, Hanin — National Engineering School of Gabes
Lamouchi, Rihab — National Engineering School of Gabes
Amairi, Messaoud — National Engineering School of Gabes

A functional interval estimation method is proposed for Linear Parameter-Varying (LPV) multivariable systems with unknown but bounded disturbances and measurement noises. Based on the interval analysis, the proposed estimator provides the upper and lower bounds of the linear functional state. An L1 formalism is used to improve stability and estimation accuracy. The design conditions are given in terms of Linear Matrix Inequalities (LMIs). Finally, a numerical example is applied to check the effectiveness of the proposed methodology.

17:50-18:10 TuC3.5

Controllers Coordination for Diesel Engines NOx Emissions Management, pp. 448-453

Ventura, Loris — Politecnico Di Torino
Malan, Stefano Alberto — Politecnico Di Torino

Tightened diesel pollutants emissions regulations rendered the performance of steady-state map controls, which are commonly used in Internal Combustion Engine (ICE) management, unsatisfactory. To overcome these performance constraints, control systems must deal with engine transient operation, subsystem coupling and the trade-off between different requirements to efficiently manage the engine. The research demonstrates the utility of a reference generator for coordinating the air path and combustion control systems of a turbocharged diesel engine for heavy-duty applications. The control system coordinator is based on neural networks and allows following different engine-out Nitrogen Oxides (NOx) targets while satisfying the load request. The main idea is to generate air path targets, intake O2 concentration and Intake MAnifold Pressure (IMAP), in accordance with the ones of the combustion control system, engine load, in the form of Brake Mean Effective Pressure (BMEP), and NOx. As a result, the air path control system provides the global conditions for the engine proper operation, while the combustion control responds to rapid changes in the engine operating state and compensates for any remaining deviations from load and NOx targets. The reference generator, as well as the two controllers, are suitable for real-time implementation on rapid-prototyping hardware. The performance was overall good, achieving average deviations of 0.1 bar for the BMEP and 150 ppm for the NOx.

18:10-18:30 TuC3.6

Vehicle Rollover Index Estimation Using a Nonlinear Unknown Input Observer, pp. 454-459

Codjia, Denakpo J. — University of Evry
Boutat-Baddas, Latifa — University of Lorraine
Alma, Marouane — University of Lorraine
Haddad, Madjid — SEGULA TECHNOLOGIES
Zemouche, Ali — University of Lorraine

This paper proposes an LMI-based nonlinear unknown input observer to estimate the rollover index of the autonomous vehicle, whether the rollover is tripped or untripped. To tackle the rollover prevention-related model, some transformations are introduced with the goal to satisfy specific necessary rank conditions and to simplify the structure of the nonlinear model. In addition, to propose a more general method, the $mathcal{L}_2-$optimality criterion is considered in order to get an estimation with $mathcal{H}_infty$ performance with respect to system disturbances and measurement noises. After presenting the generic numerical design procedure, simulations using Matlab/Simulink and CarSim are provided. The results obtained from CarSim simulations show that the developed nonlinear observer reliably estimates the vehicle states, the unknown normal tire forces, and the rollover index to predict tripped and untripped rollovers.

TuC4 Tefkros

Developing an Ubiquitous Automation and Control Paradigm for Congested Transportation Systems (Invited Session)

Chair: Geroliminis, Nikolas — Ecole Polytechnique Fédérale De Lausanne (EPFL), Urban Transport Systems Laboratory
Co-Chair: Lygeros, John — ETH Zurich
Organizer: Geroliminis, Nikolas — Ecole Polytechnique Fédérale De Lausanne (EPFL), Urban Transport Systems Laboratory
Organizer: Lygeros, John — ETH Zurich

16:30-16:50 TuC4.1

Two-Layer Adaptive Signal Control Framework for Large-Scale Networks (I), pp. 460-465

Tsitsokas, Dimitrios — Ecole Polytechnique Fédérale De Lausanne (EPFL)
Kouvelas, Anastasios — ETH Zurich
Geroliminis, Nikolas — Ecole Polytechnique Fédérale De Lausanne (EPFL)

In this paper, the effectiveness of network-wide parallel application of PC and MP strategies embedded in a two-layer control framework is assessed in a link-level dynamic traffic simulation environment. With the aim of reducing MP implementation cost without significant performance loss, partial MP deployment to node subsets is examined, based on a node importance assessment method that is

proposed. Different configurations of the two-layer framework for a real large-scale network are tested in moderate and highly congested conditions. Results show that: (i) combined control of MP and PC outperforms individual MP/PC application in both demand scenarios tested; (ii) MP control in critical node sets leads to similar or even better performance compared to full-network implementation, thus allowing for significant cost reduction.

16:50-17:10 TuC4.2

Karma Priority Lanes for Fair and Efficient Bottleneck Congestion Management (I), pp. 466-471

Elokda, Ezzat ETH Zurich
Cenedese, Carlo ETH Zurich
Zhang, Kenan ETH Zurich
Censi, Andrea MIT
Lygeros, John ETH Zurich
Frazzoli, Emilio ETH Zürich

A popular remedy for the morning commute bottleneck congestion is to split the highway capacity into a managed lane that is kept in free-flow and a general purpose lane that is subject to congestion. A classical theoretical result is that the more capacity is allocated to the managed lane the less the resulting congestion. However, existing approaches to restrict access to the managed lane are primarily monetary, e.g., tolls, which severely limits the public willingness to accept them due to equity concerns. Following up on recent work which introduces karma as a completely non-monetary credit used to control access to a so-called Karma Priority (KP) lane, we first review the strategic problem of the commuters which is modeled as a dynamic population game. We then numerically investigate the effect of varying the KP lane capacity. The karma scheme is equitable with respect to different income classes irrespective of the capacity split, meanwhile achieving near-optimal traffic reduction. Thus, managing a larger fraction of the bottleneck could be more socially feasible under a karma scheme than a monetary scheme.

17:10-17:30 TuC4.3

Integrated Optimal Control for Multi-Lane Motorway Networks (I), pp. 472-479

Markantonakis, Vasileios Technical University of Crete
Papamichail, Ioannis Technical University of Crete

This paper presents a Quadratic Programming (QP) problem formulation, employing a modified multi-lane version of the well-known macroscopic Cell Transmission Model (CTM), to determine integrated optimal control actions for motorway networks. These include mainstream traffic flow control (MTFC), lane change control (LCC), ramp metering control (RM) and dynamic traffic assignment (DTA) actions to be applied by Connected and Automated Vehicles (CAVs). An algorithm based on the barrier method provides a fast solution of the convex QP problem. A case study, for a hypothetical motorway network with multiple destinations and routes, demonstrates the efficiency of the open-loop solutions.

17:30-17:50 TuC4.4

Multi-Objective Optimization of Electric Autonomous Bus Trajectories Based on the Epsilon-Constraint Method (I), pp. 480-485

Pasquale, Cecilia University of Genova
Sacone, Simona University of Genova
Siri, Silvia University of Genova
Ferrara, Antonella University of Pavia

This paper deals with electric automated buses that have to follow a given route in inter-urban roads including stops, with a given timetable. Some stops are provided with a charging infrastructure allowing to charge the batteries while others are not. In order to control these buses, it is necessary to account for the traffic conditions along the road and to minimize two objectives, respectively related to the minimization of the deviations from the timetable and the minimization of the energy lack, at the end of the bus route, with respect to a desired final energy level. To address this problem and to investigate the conflicting nature of these objectives, two multi-objective methods based on the epsilon-constraint approach are applied in this paper, allowing to find different sets of efficient solutions for the problem. The results obtained in a real case study show that the two objective are in conflict, and compromise solutions can be found using the methods proposed in this paper.

17:50-18:10 TuC4.5

On the Effect of Capacity Drops in Highways with Service Stations (I), pp. 486-491

Cenedese, Carlo ETH Zurich
Lucchini, Matteo University of Pavia
Cucuzzella, Michele University of Pavia
Ferrara, Antonella University of Pavia
Lygeros, John ETH Zurich

This paper studies the capacity drops phenomena on a macroscopic, first-order model for freeway traffic. In particular, we focus on the effect that a service station (ST) has on the mainstream traffic evolution. We propose a modified formulation of the Cell Transmission Model with service station (CTM-s) that considers this important phenomenon, and use a micro-simulation based on Aimsun Next to identify the model parameters via a structured identification procedure. Finally, we validate the ability of the CTM-s with capacity drops to better describe the traffic evolution with respect to the classical formulation.

18:10-18:30 TuC4.6

A Macroscopic Approach for the On-Time Arrival Problem (I), pp. 492-494

Menelaou, Charalambos University of Cyprus
Timotheou, Stelios University of Cyprus
Panayiotou, Christos University of Cyprus

This work proposes a novel formulation for the On-Time Arrival (OTA) problem based on macroscopic traffic dynamics. The OTA problem is formulated as a multi-objective optimization problem considering two objective criteria. The first criterion aims to avoid the emergence of congestion by minimizing the travel time of all vehicles in the network. The second criterion seeks to reduce the discrepancy between the actual and desired arrival time. The proposed formulation results in a nonlinear multi-objective program solved efficiently through an approximated convex solution. Finally, simulation results show that the proposed methodology can significantly reduce congestion while ensuring that most vehicles arrive at their desired time.

TuC5	Evagoras
Intelligent Systems and Learning Methods in Control and Decision Support Systems (Invited Session)	
Chair: Menegatti, Danilo	University of Rome "La Sapienza"
Co-Chair: Giuseppi, Alessandro	La Sapienza
Organizer: Menegatti, Danilo	University of Rome "La Sapienza"
Organizer: Giuseppi, Alessandro	La Sapienza
Organizer: De Santis, Emanuele	Sapienza University of Rome
Organizer: Manfredi, Sabato	University of Naples Federico II
Organizer: Pietrabissa, Antonio	Consorzio Per La Ricerca nell'Automatica E Nelle Telecomunicazioni (CRAT)

16:30-16:50 TuC5.1

Behavioural Cloning for Serious Games in Support of Pediatric Neurorehabilitation (I), pp. 495-500

Baldisseri, Federico	Sapienza University of Rome
Montecchiani, Edoardo	Consortium for the Research in Automation and Telecommunication
Maiani, Arturo	Sapienza University of Rome
Menegatti, Danilo	Sapienza University of Rome
Giuseppi, Alessandro	Sapienza University of Rome
Pietrabissa, Antonio	Consortium for the Research in Automation and Telecommunication
Fogliati, Vincenzo	Consortium for the Research in Automation and Telecommunication
Delli Priscoli, Francesco	Sapienza University of Rome

Behavioural Cloning is a Machine Learning method concerning how a machine attempts to autonomously mimic the actions of a human, or in general a complex controller, performing a given task. This work innovatively exploits Behavioural Cloning in support of Pediatric Neurorehabilitation. In particular, an Artificial Neural Network Classifier has been implemented to autonomously adapt the difficulty, through a set of tunable parameters, of a Serious Game that was specifically developed to stimulate some relevant cognitive capabilities of the patient. Data augmentation via Behavioural Cloning allows such autonomous difficulty adaptation system to improve its classification performances and, thus, to enforce a control logic that, in turn, improves the effectiveness of the cognitive training. The system is validated through an experimental assessment on a Serious Game that trains motor coordination: experimental results of children gameplay are analyzed and discussed.

16:50-17:10 TuC5.2

An Intelligent Ground Station Selection Algorithm in Satellite Optical Communications Via Deep Learning (I), pp. 501-507

Wrona, Andrea	Sapienza University of Rome
De Santis, Emanuele	Sapienza University of Rome
Delli Priscoli, Francesco	Sapienza University of Rome
Lavacca, Francesco Giacinto	Sapienza University of Rome

Among the most common issues to be faced in optical satellite communications, weather conditions play a fundamental role for a correct transmission of the information. In case of heavy rain, hailstorm or snow, but even dense clouds, a communication channel between the satellite and a optical ground station (OGS) may suffer significant interference, causing errors in delivering information. Since satellite transmissions cover in general very spread areas, it usually happens that different zones are characterized by different weather conditions. This property is exploited by the site diversity technique, that tries to limit bad weather effects on the overall availability of the communication channel. When implementing such a site diversity technique, the satellite should be able to switch between the OGSs, by evaluating the rain events probability either through direct measurement campaigns or exploiting statistical models. The setup studied in this work is composed by a geostationary satellite equipped with two laser communication terminals (LCTs). In order to dynamically decide the OGSs to be pointed by those LCTs, a Deep-Learning based proactive control algorithm for site diversity, performing weather forecasting and consequent preventive LCT switching on the basis of current and past weather conditions has been developed. Simulative results show the ability of our proposed algorithm in achieving the maximum possible link availability, which is bounded by the weather conditions of all the OGSs.

17:10-17:30 TuC5.3

Load Demand Prediction for Electric Vehicles Smart Charging through Consensus-Based Federated Learning (I), pp. 508-514

Menegatti, Danilo	Sapienza University of Rome
Pietrabissa, Antonio	Consortium for the Research in Automation and Telecommunication
Manfredi, Sabato	University of Naples Federico II

Giuseppi, Alessandro — Sapienza University of Rome

Having access to a reliable and accurate prediction of the short-term power demand is a fundamental step for the widespread adoption of Electric Vehicles (EVs), as their charges may have a significant impact on the power system balancing. In this direction, we propose a short-term load demand predictor, based on distributed Long Short-Term Memory Networks, that employs consensus and fully-decentralized Federated Learning (FL) algorithms to seek cooperation among multiple points of charge without the requirement of sharing any user-related data.

17:30-17:50 TuC5.4

Deep Image Inpainting to Support Endoscopic Procedures (I), pp. 515-520

Menegatti, Danilo — Sapienza University of Rome
Betello, Filippo — Sapienza University of Rome
Delli Priscoli, Francesco — Sapienza University of Rome
Giuseppi, Alessandro — Sapienza University of Rome

Deep image inpainting is a computer vision task that uses Deep Neural Networks to generate plausible content to complete an image, for example for the restoration of a damaged image or the removal of unwanted elements captured in the picture. This paper uses deep image inpainting to restore endoscopic images that are affected by various types of artifacts. To this end, we developed a transfer learning-based procedure that uses the CSA inpainting model, which was originally proposed for unrelated tasks including the restoration of images from the Paris StreetView Dataset. The opposed system is trained and validated on the EndoCV2020 dataset, consisting of images from real endoscopies, highlighting how deep image inpainting may be a promising technology for frame restoration during medical procedures.

17:50-18:10 TuC5.5

Landslide Susceptibility Prediction from Satellite Data through an Intelligent System Based on Deep Learning (I), pp. 521-528

Giuseppi, Alessandro — Sapienza University of Rome
Lo Porto, Leonardo Pio — Sapienza University of Rome
Wrona, Andrea — Sapienza University of Rome
Menegatti, Danilo — Sapienza University of Rome

Landslides are critical natural hazards whose frequency and severity are increasing due to climate change and human activities. The consequences of landslides are severe and can lead to the destruction of homes, infrastructures and the contamination of water supplies, with severe impact also on the local ecosystems and the disruption of natural habitats. This article examines the application of an ad-hoc neural network-based intelligent system to evaluate the landslide susceptibility of the terrain on the basis of satellite data. The proposed system is validated on data from Lombardia and Abruzzo, two Italian regions that have been particularly subject to the landslide phenomenon. Results indicate that the CNN model is able to correctly identify landslide occurrences with high accuracy, demonstrating that CNNs are capable of providing accurate susceptibility mapping at a local scale and surpassing the performance of existing solutions available in the literature.

18:10-18:30 TuC5.6

Vertically-Advised Federated Learning for Multi-Strategic Stock Predictions through Stochastic Attention-Based LSTM (I), pp. 529-536

Menegatti, Danilo — Sapienza University of Rome
Ciccarelli, Emanuele — Sapienza University of Rome
Viscione, Michele — Sapienza University of Rome
Giuseppi, Alessandro — Sapienza University of Rome

In recent years, stock price forecasting has become a challenging task commonly used to evaluate the performance of various machine learning solutions. This work explores a Federated Learning (FL) framework within a competitive collaboration scenario with the aim of training a centralised model advised by non-recoverable decentralised strategies so that no exchange of private data is required. The proposed Vertically-Advised Federated Learning (VAFL) framework combines elements from both horizontal and vertical FL, as each client trains two independent models. Furthermore, a novel forecasting architecture, based on a stochastic variant of an Attention-based Long Short Term Memory (LSTM) network, is proposed and validated on a simulated scenario based on real data from the stock market.

18:30-18:50 TuC5.7

Point2Depth: A GAN-Based Contrastive Learning Approach for mmWave Point Clouds to Depth Images Transformation (I), pp. 537-544

Brescia, Walter — Politecnico Di Bari
Roberto, Giuseppe — Politecnico Di Bari
Racanelli, Vito Andrea — Politecnico Di Bari
Mascolo, Saverio — Politecnico Di Bari
De Cicco, Luca — Politecnico Di Bari

The perception of the environment is essential in mobile robotics applications as it enables the proper planning and execution of efficient navigation strategies. Optical sensors offer many advantages, ranging from precision to understandability, but they can be significantly impacted by lighting conditions and the composition of the surroundings. In contrast, millimeter wave (mmWave) radar sensors are not influenced by such adverse conditions. and are capable of detecting partially or fully obstructed obstacles, resulting in more informative point clouds. However, such point clouds are often sparse and noisy. This work presents a cross-modal contrastive learning approach based on Conditional Generative Adversarial Networks (cGANs) to transform sparse point clouds from mmWave sensors into depth images, preserving the distance information while producing a more comprehensible representation. An extensive data collection phase was conducted to create a rich multimodal dataset with each information associated with a timestamp and a pose. The experimental results demonstrate that the approach is able to produce accurate depth images, even in challenging environmental conditions.

WeA1	Grand Hall A
Robotics (I) (Regular Session)	
Chair: Gasparri, Andrea	Università Degli Studi Roma Tre
Co-Chair: Tika, Argtim	RPTU Kaiserslautern

10:30-10:50 WeA1.1

Visual Imitation Learning for Robotic Fresh Mushroom Harvesting, pp. 545-550

Porichis, Antonios — University of Essex
Vasios, Konstantinos — University of Essex
Iglezou, Myrto — TWI Hellas
Mohan, Vishwanathan — University of Essex
Chatzakos, Panagiotis — University of Essex

Imitation Learning holds significant promise in enabling the automation of complex robotic manipulations tasks which are impossible to explicitly program. Mushroom harvesting is a task of high difficulty requiring weeks of intense training even for humans to master. In this work we present an end-to-end Imitation Learning pipeline that learns to apply the series of motions, namely reaching, grasping, twisting, and pulling the mushroom directly from pixel-level information. Mushroom harvesting experiments are carried out within a simulated environment that models the mushroom dynamics based on von Mises yielding theory with parameters obtained through expert picker demonstration wearing gloves with force sensors. We test the robustness of our technique by performing randomizations on the camera extrinsic and intrinsic parameters as well as on the mushroom sizes. We also evaluate on different kinds of visual input namely grayscale and depth maps. Overall, our technique shows significant promise in automating mushroom harvesting directly from visual input while being remarkably lean in terms of computation intensity. Our models can be trained on a standard Laptop GPU in under one hour while inference of an action takes less than 1.5ms on a Laptop CPU. A brief overview of our experiments in video format is available at: https://bit.ly/41kCH7T

10:50-11:10 WeA1.2

An Optimal Allocation and Scheduling Method in Human-Multi-Robot Precision Agriculture Settings, pp. 551-556

Lippi, Martina — Roma Tre University
Gallou, Jorand — Roma Tre University
Gasparri, Andrea — Roma Tre University
Marino, Alessandro — University of Cassino

Employing teams of robots to offer services to human operators enables the latter to reduce their physical workload. In this paper, we focus on the problem of optimally allocating and scheduling the robot tasks in order to serve human operators. We formulate a Mixed-Integer Linear Programming problem which aims to minimize the human waiting time and the energy spent by the robots, while ensuring that any velocity constraints of the robots are fulfilled and the task ordering is correct. In addition, we propose an online re-allocation strategy that takes into account the possibility of changing human parameters over time. This strategy determines whether a new optimal solution must be computed. We validate the proposed framework in a simulated precision agriculture setting composed of two robots and four human operators for a harvesting application.

11:10-11:30 WeA1.3

Tethering a Human with a Quadruped Robot: A Guide Dog to Help Visually Impaired People, pp. 557-563

Morlando, Viviana — University of Naples Federico II
Lippiello, Vincenzo — University of Naples Federico II
Ruggiero, Fabio — University of Naples Federico II

This paper devises a framework to control a quadruped robot tethered to a visually impaired person. The whole-body control of the quadruped robot does not exploit any force sensor. It makes use of two observers: the former for the estimation of the wrench applied on the robot's centre of mass, which is in turn used to handle the human-robot estimation; the latter for the estimation of the external forces acting on the legs to guarantee a stable balance on irregular terrains. Besides, an admittance filter is employed to guarantee a safe human-robot interaction. A supervisor is designed and placed side by side with the quadruped whole-body control to understand human needs and handle lifelike situations. The validity of the approach is tested in a realistic simulation environment.

11:30-11:50 WeA1.4

Energy and Angular Momentum Control of Robot Running, pp. 564-571

Giordano, Alessandro Massimo — DLR (German Space Center), Technical University of Munich
Stivala, Simone — University of Trento
Calzolari, Davide — Technical University of Munich
Albu-Schäffer, Alin — Technical University of Munich, DLR (German Space Center)

A new approach for running by exploiting passive elastic dynamics is addressed in this paper. A control method based on energy and angular momentum regulation is proposed. The controller exploits invariance properties of energy and angular momentum to achieve stabilization of passive gaits with almost zero control effort after convergence. The passive gaits are derived based on a modified version of the well-known SLIP model, which takes into account the pitch dynamics during the flight phase, which is otherwise disregarded by the conventional SLIP model. Based on this model, the interesting phenomenon of running in presence of persistent somersaulting is investigated and persistently-somersaulting running gaits are identified and analyzed.

Numerical simulations validate the method and confirm the effectiveness in ideal conditions.

11:50-12:10 WeA1.5

Optimization-Based Task and Trajectory Planning for Robot Manipulators, pp. 572-578

Tika, Argtim — Rhineland-Palatinate Technical University Kaiserslautern-Landau
Bajcinca, Naim — Rhineland-Palatinate Technical University Kaiserslautern-Landau

We introduce optimization-based algorithms that address the problem of robot task scheduling and trajectory planning. Following a two-layer hierarchical control structure, we first decouple the task scheduling from the trajectory planning by introducing two separate optimization problems, a discrete one for task scheduling and a continuous optimization problem for trajectory planning. In a further step, we integrate both planning layers into a monolithic layer in the form of a mixed-integer recursive optimization problem. The algorithms are implemented and validated using Robot Operating System (ROS) on an experimental setup with a robot manipulator performing pick-and-place tasks.

12:10-12:30 WeA1.6

System Identification of an Elastomeric Series Elastic Actuator Using Black-Box models, pp. 579-585

Fernandes, Diogo Lopes — Pontifical Catholic University of Rio De Janeiro
Hultmann Ayala, Helon Vicente — Pontifical Catholic University of Rio De Janeiro
Meggiolaro, Marco Antonio — Pontifical Catholic University of Rio De Janeiro

Flexible manipulators are the core technology to the development of collaborative robotic systems, which is a trend in Industrial Robotics. Hence, the system and parameter identification of these systems is important to develop more accurate strategies of control based on the known dynamic behavior of these joints. The purpose of this paper is to build linear and nonlinear auto-regressive models with exogenous inputs based on experimental data. The data set used was collected with an experimental setup using a multi-sine torque input signal applied to the motor, and the output was the angular velocity of the link. The models employed were the ARX, ARMAX, NARMAX, and NARX-NN, and their performance was measured using the root-mean-squared error and the R^2 score. The results show that all the models presented good performance, with an acceptable R^2 score and an RMSE value close to each other.

WeA2 — Grand Hall B

Computational Intelligence (Regular Session)

Chair: Puig, Vicenç — Universitat Politècnica De Catalunya (UPC)
Co-Chair: Stamatescu, Grigore — University Politehnica of Bucharest

10:30-10:50 WeA2.1

Evaluation of Deep Learning and Machine Learning Algorithms for Building Occupancy Classification on Open Datasets, pp. 586-591

Cretu, Georgiana Madalina — Polytechnic University of Bucharest
Stamatescu, Iulia — Polytechnic University of Bucharest
Stamatescu, Grigore — Polytechnic University of Bucharest

Accurately estimating and forecasting building occupancy represents an important tasks for higher level indoor energy management and control routines. Extended availability of public and open datasets reflecting indoor conditions through various sensor measurement and indirect proxies of human activity enable reliable benchmarking of new techniques for pre-processing and learning of occupancy patterns. In this work we present a comparative study between deep learning, such as convolutional neural networks, and conventional machine learning approaches, such as decision trees and random forests, on an a reference occupancy dataset. The various design deci- sion and parametrisation options are discussed. The building occupancy classification task involves generating model outputs for various discrete occupancy categories. Standardised metrics such as accuracy, precision, recall and the F1-score are used for replicable benchmarking of the results. Main finding of the study is that, though generally the deep learning methods offer better overall results, the addition of relevant features (sensors) to the input dataset can yield better results for the conventional machine learning models with significantly lower training time and model size. This results in suitable, fast-inference, models for embedded deployment in physical proximity to the process.

10:50-11:10 WeA2.2

Nonlinear State Observer for PMSM with Evolutionary Algorithm, pp. 592-597

Bazylev, Dmitry — ITMO University
Pyrkin, Anton — ITMO University
Dobriborsci, Dmitrii — Deggendorf Institute of Technology

This paper is addressed to a problem of state observation for permanent magnet synchronous motor (PMSM) and its design parameter tuning via evolutionary algorithm. Recently proposed flux, position and speed observer that is based on nonlinear parameterization of motor model and dynamic regressor extension and mixing (DREM) technique is considered. Though global asymptotic convergence of this observer was guaranteed for all positive real values of several design parameters the choice of their values for a particular motor was not well considered. To overcome this drawback a genetic algorithm is used to perform automatic tuning of required coefficients minimizing cost function that is associated with estimation errors. Simulation results supplemented by verification demonstrate the efficiency of the proposed approach resulting in a set of easy-to-implement-in-practice values of design parameters.

11:10-11:30 WeA2.3

Analyzing the Effects of Confidence Thresholds on Opinion Clustering in Homogeneous Hegselmann–Krause Models, pp. 598-603

Srivastava, Trisha — University of Sannio
Bernardo, Carmela — Linköping University
Altafini, Claudio — Linköping University
Vasca, Francesco — University of Sannio

Hegselmann--Krause (HK) models exhibit complex behaviors which are not easily tractable through mathematical analysis. In this paper,

a characterization of the steady-state behaviors of homogeneous HK models and sensitivity to confidence thresholds is discussed by commenting on existing and new numerical results. The typical decreasing of number of clusters and convergence time by increasing the confidence thresholds are discussed and motivations for the behavior of some counterexamples are provided. A tighter upper bound for the dependence of the number of clusters with respect to the confidence thresholds is proposed. Differences and analogies between the opinions' evolution for symmetric and asymmetric HK models are commented.

11:30-11:50 WeA2.4

FedAcc and FedAccSize: Aggregation Methods for Federated Learning Applications, pp. 604-609

Bejenar, Iuliana - Alexandra — Gheorghe Asachi Technical University of Iasi
Ferariu, Lavinia — Gheorghe Asachi Technical University of Iasi
Pascal, Carlos — Gheorghe Asachi Technical University of Iasi
Caruntu, Constantin-Florin — Gheorghe Asachi Technical University of Iasi

This paper presents the ability of the federated learning concept to create a collaboration between multiple devices using a shared global model, while still keeping data privacy to meet the General Data Protection Regulation (GDPR). In real-world application scenarios, this concept faces problems related to the defense of the global model from possible attacks and the compatibility with non-independent and identically distributed data (non-IID). This paper presents two aggregation algorithms compatible with non-IID data, which use a refined aggregation of the local model, based on their accuracy. Thus, the proposed algorithms can refine the confidence in each client, eliminate intruders and allow a safe aggregation of the global model. Testing scenarios performed for IID and non-IID data illustrate that the proposed algorithms are able to provide faster training and improved robustness against intruders, w.r.t. the well-known federated average algorithm.

11:50-12:10 WeA2.5

A Generalized Approach for Feature Selection in Water Quality Monitoring, pp. 610-615

Pavone, Marino — University of L'Aquila
Epicoco, Nicola — Free Mediterranean University
Magliocca, Francesco — Sensichips Srl
Pola, Giordano — University of L'Aquila

The application of Artificial Intelligence (AI) and Machine Learning (ML) in IoT smart sensor technologies has opened wide possibilities in the field of Water Quality Monitoring (WQM). Power saving and price-per-unit requirements, fundamentals for Wide Distributed Sensors Networks (WDSN), drive research in developing AI-model reduction techniques to make algorithms faster and cheaper in terms of hardware resources and battery consumption. Before any optimization process, Feature Selection (FS) is needed to reduce the number of basic operations in smart sensors workflow, thus making lighter the data acquiring phase and decreasing the size of data input for the subsequent AI process. However, selecting the FS method that best fits the specific requirements of the considered application is not trivial, given the numerous available FS methods and the relevant number of possible feature subsets. In this context, this paper presents a generalized and versatile algorithm, based on the concept of ensemble-FS, to support and speed up the AI-unit design process. The method compares different FS methods, effectively providing precise information about the accuracy (and any other requirement) of the selected FS method with respect to the number of acquired features. The proposed methodology is tested on a real WQM case study by analyzing the obtained results when both the popular and high-performer XGBoost algorithm and some ready-to-use FS-ranker methods in the Waikato Environment for Knowledge Analysis (WEKA) are used. Results show that the XGboost is the best performer for the case study in terms of stability and accuracy.

12:10-12:30 WeA2.6

Gaussian Sampling Approach to Deal with Imbalanced Telemetry Datasets in Industrial Applications, pp. 616-622

Galve, Sergio — Universitat Oberta De Catalunya
Puig, Vicenç — Universitat Politècnica De Catalunya (UPC)
Vilajosana, Xavi — Universitat Oberta De Catalunya

Practical implementation of data analytics in industrial environments has always been a problematic area because of data availability and quality. In this paper, a Gaussian sampling methodology is proposed to address the problem of imbalanced telemetry datasets that is one of the root causes that make modelling less reliable. By generating subsets that achieve homogeneous density distributions this problem is addressed. By comparing the impact of this method with the baseline case of random sampling, this paper aims to address this problem and propose a practical solution. A case study based on an industrial cooling device is used to assess and illustrate the proposed approach.

WeA3 Grand Hall C

Nonlinear Control (I) (Regular Session)

Chair: El hajjaji, Ahmed — University of Picardie Jules Verne
Co-Chair: Sacchi, Nikolas — University of Pavia

10:30-10:50 WeA3.1

Adaptive Integral Sliding Mode Control for Constrained Quadrotor Trajectory Tracking, pp. 623-628

Sidi Brahim, Khelil — University of Picardy Jules Verne
El hajjaji, Ahmed — University of Picardy Jules Verne
Terki, Nadjiba — University of Biskra
Lara David, David — Higher Technological Institute of Misantla

This paper deals with the constrained position and angle tracking control design for quadrotor under unknown upper bound disturbances. An adaptive integral sliding mode control (AISMC) is proposed to perform the position and angle tracking for the quadrotor subject the severe disturbances and input saturation constraints. The proposed approach that does not require a priori knowledge of disturbance boundaries, allows through an adaptation dynamic law to reduce the computing effort, to obtain a good tracking, and to avoid an

overestimation of the gain of the mode sliding that will automatically handle input saturation constraints. Stability and convergence in finite time are proved by Lyapunov theory. The efficiency of the proposed method is shown by simulation.

10:50-11:10 WeA3.2

Sliding Mode Control for a Class of Systems Based on a Non-Monotonic Lyapunov Function, pp. 629-634

Prasun, Parijat — Indian Institute of Technology, Varanasi
Singh, Vijay Kumar — Indian Institute of Technology, Varanasi
Pandey, Vinay — Indian Institute of Technology, Varanasi
Kamal, Shyam — Indian Institute of Technology, Varanasi
Ghosh, Sandip — Indian Institute of Technology, Varanasi
Osinenko, Pavel — Skoltech
Parsegov, Sergei — Institute of Control Sciences, Russian Academy of Sciences

This article discusses the sliding mode control problem, where the reaching phase is achieved non-monotonically, and the sliding phase can be achieved either monotonically or non-monotonically. Once the reaching phase is completed, the state variables slide on the sliding manifold and then reach the equilibrium point. A practical second-order example of the ball motion model is considered to show the non-monotonic reaching phase. Simulation results verify the non-monotonic behavior of the reaching phase.

11:10-11:30 WeA3.3

Neural Network Based Integral Sliding Mode Control of Systems with Time-Varying State Constraints, pp. 635-640

Sacchi, Nikolas — University of Pavia
Vacchini, Edoardo — University of Pavia
Ferrara, Antonella — University of Pavia

In this paper, we propose a novel neural network based state constrained integral sliding mode (NN-SCISM) control algorithm for nonlinear system with partially unknown dynamics in presence of time-varying constraints. In particular, the drift term characterizing the system dynamics is estimated by using a two-layer neural network, whose weights are adjusted according to adaptation laws designed relying on stability analysis. Thanks to a sliding variable which varies depending on the minimum distance between the system state and the current closest constraint, the control algorithm is able to drive the system state to a desired target state, while avoiding the forbidden states contained in the time-varying set delimited by the constraints. The proposal has been theoretical analysed and assessed in simulation.

WeA4 Tefkros

Robust Control and Estimation (Regular Session)

Chair: Gershon, Eli — Holon Institue of Technology
Co-Chair: Nesci, Francesca — Universita' Degli Studi Magna Graecia Di Catanzaro

10:30-10:50 WeA4.1

Mixed FTS/H∞ Control for Nonlinear Quadratic Systems Subject to Norm-Bounded Disturbances, pp. 641-646

Merola, Alessio — Magna Græcia University of Catanzaro
Nesci, Francesca — Magna Græcia University of Catanzaro
Dragone, Donatella — Magna Græcia University of Catanzaro
Amato, Francesco — University of Naples Federico II
Cosentino, Carlo — Magna Græcia University of Catanzaro

In this paper, the mixed Finite-Time Stability (FTS)/$mathcal H_infty$ control problem is investigated for the class of nonlinear quadratic systems (NLQSs), which have several relevant applications, e.g., in robotics, systems biology and other domains of applied sciences. Sufficient conditions are provided here to solve synthesis problems, in the presence of both norm-bounded disturbances, constraints on initial and terminal conditions, and finite-time bounds on the output transient. More specifically, taking into account such constraints within the design phase, allows to achieve a desired $mathcal H_infty$ performance with nonzero initial conditions, while simultaneously guaranteeing that a given NLQS is finite-time stable for all admissible uncertainties and disturbances. Such conditions can be formulated as Linear Matrix Inequalities (LMIs) optimization problem. The applicability of the proposed results is illustrated by means of a numerical example.

10:50-11:10 WeA4.2

Robust Sparse Filtering under Bounded Exogenous Disturbances, pp. 647-652

Khlebnikov, Mikhail — V. A. Trapeznikov Institute of Control Sciences, RAS
Tremba, Andrey — V. A. Trapeznikov Institute of Control Sciences, RAS

An approach to the solution of a robust sparse filtering problem via use of a reduced number of outputs under arbitrary bounded external disturbances and norm-bounded system uncertainties using an observer is proposed. The approach is based on the LMI technique and the method of invariant ellipsoids, and made it possible to reduce the initial problem to parameterized semidefinite programming that can be easily solved numerically. Two ways to control sparsity are proposed: controlled relaxation approach and Pareto frontier approach.

11:10-11:30 WeA4.3

Anisotropy-Based Approach of Estimating for Sensors Network with Nonzero Mean of Input, pp. 653-658

Yurchenkov, Alexander — V. A. Trapeznikov Institute of Control Sciences
Kustov, Arkadiy — V. A. Trapeznikov Institute of Control Sciences

In this paper, a discrete time-varying model of sensors network is considered. The external input belongs to the class of sequences of random vectors with bounded anisotropy of the extended vector. The anisotropy-based analysis of the system includes the analysis for

the multiplicative noise systems and the boundedness criterion of the anisotropic norm. The considering problem concerns the selection of the estimator, which one guarantees the boundedness anisotropic norm. It is demonstrated how to reduce considering problem to convex optimization one.

11:30-11:50 WeA4.4

State Estimation for Stochastic State Multiplicative Systems, pp. 659-663

Gershon, Eli Holon Institue of Technology

The problem of H_infty state estimation is considered for uncertain polytopic linear discrete-time stochastic state-multiplicative systems. We first bring the a unique version of the BRL for the latter systems which allows for vertex-dependent solution in the uncertain case. Following the BRL derivation, we solve the estimation problem for nominal systems which serve as a basis for the extracting the filter parameters in the uncertain case. In both cases: the nominal and the uncertain cases, the filter parameters are extracted by a solving an LMI condition in the former case or a set of LMIs in the latter case, both of which depend on a minimal set of tuning parameters, thus greatly reduce the over-design. The theory presented is demonstrated by a numerical example.

11:50-12:10 WeA4.5

Terminal-Set-Based Optimal Stochastic Guidance, pp. 664-669

Mudrik, Liraz Technion - Israel Institute of Technology
Oshman, Yaakov Technion - Israel Institute of Technology

In stochastic interception scenarios, an intercepting missile only has uncertain information about the target state, as this information is obtained from noisy measurements. The true dynamics of the target are also unavailable to the intercepting missile, so, instead, the interceptor can assume that the target possesses ideal dynamics, which amounts to adopting the worst-case scenario. Moreover, even when linear models and Gaussian noises are assumed, the notorious curse of dimensionality renders the straightforward optimal solution to this problem intractable in real-time. To alleviate the computational burden, this work uses an approach based on the notion of terminal sets to present an optimal interception strategy for stochastic scenarios. We show that using this approach greatly reduces the computational effort, as the number of modes diverges quadratically in time instead of exponentially. Another computational burden reduction is achieved via a novel decomposition of the interceptor's terminal set. These results render the proposed strategy implementable in real-time, as the horizon is sufficiently short at the endgame stage of the engagement. A Monte Carlo simulation study is used to demonstrate the performance of the novel guidance law in stochastic scenarios, and to show that it achieves real-time performance despite its (still) considerable computational burden.

WeA5 Evagoras

Distributed Systems (Regular Session)

Chair: Horn, Joachim Helmut-Schmidt-University / University of the Federal Armed Forces Hamburg

Co-Chair: Petrillo, Alberto University of Naples Federico II

10:30-10:50 WeA5.1

Distributed Consensus Control of Homogeneous Vehicle Platoons with Bidirectional Communication, pp. 670-677

Gaagai, Ramzi Helmut Schmidt University
Seeland, Felix Helmut Schmidt University
Horn, Joachim Helmut Schmidt University

Vehicle platooning is deemed a promising solution to improve traffic safety, reduce fuel consumption and increase traffic throughput and road capacity.Road throughput can be increased by driving at small inter-vehicle distances. Adjusting the spacing with both the preceding and the succeeding vehicles using bidirectional communication can potentially improve the platoon cohesiveness and is crucial when considering the synchronized merging scenario. In this paper, a distributed consensus controller is presented which relies on bidirectional platoon communication. Along with the consensus-based controller synthesis, platoon stability proof and string stability analysis, effectiveness of the controller is verified in a simulation study.

10:50-11:10 WeA5.2

Cooperative Adaptive Cruise Control of Heterogeneous Vehicle Platoons with Bidirectional Communication, pp. 678-684

Gaagai, Ramzi Helmut Schmidt University
Seeland, Felix Helmut Schmidt University
Horn, Joachim Helmut Schmidt University

Vehicle platooning is deemed a promising solution to improve traffic safety, reduce fuel consumption and increase traffic throughput and road capacity. Road throughput can be increased by driving at small inter-vehicle distances. Adjusting the spacing with both the preceding and the succeeding vehicles using bidirectional communication can potentially improve the platoon cohesiveness and is crucial when considering the synchronized merging scenario. This paper presents vehicle controllers for cooperative adaptive cruise control (CACC) for heterogeneous vehicle platoons. To achieve desired inter-vehicle spacing with respect to a predecessor and a follower, a bidirectional communication scheme is employed. Moreover, conditions for vehicle stability are provided and string stability properties of the platoon analyzed. Finally, effectiveness of the controller is verified in a simulation study.

11:10-11:30 WeA5.3

Adaptive Distributed PI-Like Control Protocol for the Virtual Coupling of Connected Heterogeneous Uncertain Nonlinear High-Speed Trains, pp. 685-690

Petrillo, Alberto University of Naples Federico II
Basile, Giacomo University of Naples Federico II
Lui, Dario Giuseppe University of Naples Federico II
Santini, Stefania University of Naples Federico II

Virtual Coupling has been included among the most relevant innovations to be studied in the European Horizon 2020 Shift2Rail Joint Undertaking for increasing the railway lines capacity through the dynamic connection of two or more trains to form a convoy while preserving safety. Within this framework, this paper addresses the virtual coupling control problem for heterogeneous nonlinear uncertain connected high-speed trains. Leveraging the Multi-Agent Systems framework, a novel distributed robust and adaptive PI-like control scheme is proposed to solve the control problem. In order to provide suitable adaptive mechanisms for the control gains, we exploit the Lyapunov theory and Barbalat's lemma and prove the asymptotic stability for the overall networked control system, as well as the boundedness of these signals. The virtual coupling objective is achieved in a fully-distributed fashion by limiting the amount of time-varying information necessary for the computation of the control action and, hence, saving communication channel bandwidth while reducing the computational burden. Exemplary numerical simulations are given to support the theoretical derivations and to prove the effectiveness of the proposed control strategy in a real driving scenario.

11:30-11:50 WeA5.4

Dynamic Centrality in Metapopulation Networks: Incorporating Dynamics and Network Structure, pp. 691-696

Darabi, Atefe Northeastern University
Siami, Milad Northeastern University

In epidemic networks, walk-based centrality indices are often used to identify the nodes that are significantly contributing to the spread of disease. While the network topology can provide a good insight into how the disease might propagate throughout the network, epidemic-related factors can change the ranking results as well. This paper presents a dynamics-based node centrality that incorporates epidemic characteristics, internal time delays, and network structure at the same time. This centrality allows for dynamic identification of the nodes that are more sensitive to external shocks, which in turn can help prevent performance degradation in the network. It is shown that some of the prominent walk-based centralities, such as local and eigenvector centralities, are in fact correlated with dynamics-based centrality for certain epidemic parameters.

11:50-12:10 WeA5.5

Fundamental Limits on Disturbance Propagation in Virtual Viscoelastic-Based Multi-Agent Systems, pp. 697-702

Murugan, Dinesh Northeastern University
Hajian, Rozhin University of Massachusetts Lowell
Siami, Milad Northeastern University

In this paper, we investigate the performance deterioration of commensurate fractional-order consensus networks under exogenous stochastic disturbances. We formulate fractional-order differential equations for the network dynamics using Caputo derivatives and the Laplace transform, and employ the H_2 norm of the dynamical system as a performance measure. By developing a graph-theoretic methodology, we relate the structural specifications of the underlying graphs to the performance measure and explicitly quantify fundamental limits on the best achievable levels of performance in fractional-order consensus networks. We also establish new connections between the sparsity of the network and the performance measure, characterizing fundamental tradeoffs that reveal the interplay between the two. Finally, we provide numerical illustrations to verify our theoretical results, which could help in the design of robust fractional-order control systems in the presence of disturbances.

WeB1 Grand Hall A

Robotics (II) (Regular Session)

Chair: Fourlas, George K. University of Thessaly
Co-Chair: Koval, Anton Luleå University of Technology

14:00-14:20 WeB1.1

Linearized Model Predictive Control with Offset-Freeness for Trajectory Tracking on Inland Vessels, pp. 703-708

Marx, Johannes Richard University of Rostock
Damerius, Robert University of Rostock
Jeinsch, Torsten University of Rostock

Shipping goods using international waterways as well as inland waterways is one of the most important kind of transportation. With the increase of global networking, also the amount of goods exchange increases and has increased in the last decades. While sailing on open sea doesn't pose difficulties due to good assisting systems anymore, especially for low-speed maneuvering in confined waters exists a lack of reasonable control solutions. This is due high requirements in control quality and obstructive thereby non-linearities in ship dynamics and non-linear transformation from body- to earth-fixed frame. In this paper, a model predictive approach to control acting forces and moments for offset-free trajectory tracking is applied. To deal with non-linear behavior, successive linearization at every sampling interval is used. Furthermore, offset-freeness is guaranteed by reformulating the model as incremental system. The performance is validated simulatively and compared to a state of the art state controller. It turns out, that the model predictive approach outperforms the state controller in terms of control error and disturbance rejection.

14:20-14:40 WeB1.2

Modelling and Workspace Analysis for an Underwater Manipulator, pp. 709-714

Lack, Sven University of Rostock
Rentzow, Erik University of Rostock
Jeinsch, Torsten University of Rostock

Manipulation tasks in underwater operations were so far only realizable with large work class remotely operated vehicles (ROV). However, new developments in the field of miniaturized fully-electric multi-joint manipulators are opening up applications for small and medium size ROVs. Despite miniaturization of the manipulators, the manipulator-to-vehicle ratio is not identical to that of large work class ROVs. Coupling effects between manipulator and vehicle must be taken into account to ensure good controller performance of the position and attitude of the vehicle and the tool center point (TCP) of the manipulator. In this paper, the modelling of an underwater manipulator based on an extended Newton-Euler method is presented. The proposed method is applied to a Reach Alpha 5 manipulator

and validated by static measurements. Furthermore, a method for collision detection between arm parts is presented and applied to the Reach Alpha 5 for workspace analysis.

14:40-15:00 WeB1.3

Tube-Based Nonlinear MPC of an Over-Actuated Marine Platform for Navigation and Obstacle Avoidance Using Control Barrier Functions, pp. 715-720

Syntakas, Spyridon — University of Ioannina
Vlachos, Kostas — University of Ioannina

This paper presents the design of a robust tube-based nonlinear Model Predictive Control (MPC) law for a triangular marine platform, that is over-actuated with three rotating jets. The goal is safe navigation and dynamic positioning of the platform under realistic wind and wave environmental disturbances, as well as real-time obstacle avoidance employing Control Barrier Functions (CBF) as constraints in the robust MPC strategy. Extensive Monte Carlo simulations have been conducted under a control allocation scheme, taking into account the actuator thrust and rotation dynamics, sensor noise, as well as additional state and input constraints. The simulation results show that the nonlinear controller ensures robust and safe navigation with obstacle avoidance and accomplishes accurate positioning of the floating platform at a given goal pose, while satisfying the actuator limits.

15:00-15:20 WeB1.4

Control Barrier Function Based Visual Servoing for Underwater Vehicle Manipulator Systems under Operational Constraints, pp. 721-726

Heshmati Alamdari, Shahab — Aalborg University
Karras, George — University of Thessaly
Sharifi, Maryam — ABB Corporate Research
Fourlas, George K. — University of Thessaly

This paper presents a novel control strategy for image-based visual servoing (IBVS) of underwater vehicle manipulator systems (UVMS) using control barrier functions (CBFs) to handle field of view (FoV) constraints and system's operational limitations such as manipulator joint limits and vehicle velocity performances. The proposed approach combines the advantages of IBVS, which provides visual feedback for control, with CBFs, which can formally enforce visibility and safety constraints on the UVMS's motion. A CBF-based control law is derived and integrated with the IBVS algorithm, which guarantees the satisfaction of FoV and system's operational constraints and ensure stability of the closed-loop system. To deal with FoV constraints, the proposed method uses a FoV index to estimate the degree of visibility of the scene, which is used to adjust the control inputs accordingly. The effectiveness of the proposed strategy is demonstrated through realistic simulation results, showing improved performance and safety of the UVMS under FoV and operational constraints compared to traditional IBVS methods. The results indicate that the proposed approach can handle the challenging underwater environment, UVMS dynamics and the operational constraints effectively, making it a valuable control strategy for practical applications of UVMS.

15:20-15:40 WeB1.5

Multimodal Dataset from Harsh Sub-Terranean Environment with Aerosol Particles for Frontier Exploration, pp. 727-732

Kyuroson, Alexander — Luleå University of Technology
Dahlquist, Niklas — Luleå University of Technology
Stathoulopoulos, Nikolaos — Luleå University of Technology
Kottayam Viswanathan, Vignesh — Luleå University of Technology
Koval, Anton — Luleå University of Technology
Nikolakopoulos, George — Luleå University of Technology

Algorithms for autonomous navigation in environments without Global Navigation Satellite System (GNSS) coverage mainly rely on onboard perception systems. These systems commonly incorporate sensors like cameras and Light Detection and Rangings (LiDARs), the performance of which may degrade in the presence of aerosol particles. Thus, there is a need of fusing acquired data from these sensors with data from Radio Detection and Rangings (RADARs) which can penetrate through such particles. Overall, this will improve the performance of localization and collision avoidance algorithms under such environmental conditions. This paper introduces a multimodal dataset from the harsh and unstructured underground environment with aerosol particles. A detailed description of the onboard sensors and the environment, where the dataset is collected are presented to enable full evaluation of acquired data. Furthermore, the dataset contains synchronized raw data measurements from all onboard sensors in Robot Operating System (ROS) format to facilitate the evaluation of navigation, and localization algorithms in such environments. In contrast to the existing datasets, the focus of this paper is not only to capture both temporal and spatial data diversities but also to present the impact of harsh conditions on captured data. Therefore, to validate the dataset, a preliminary comparison of odometry from onboard LiDARs is presented.

WeB2 — Grand Hall B

Intelligent Control Systems (Regular Session)

Chair: Goodwine, Bill — University of Notre Dame
Co-Chair: Timotheou, Stelios — University of Cyprus

14:00-14:20 WeB2.1

Staggered School Schedules for the Morning Commute Problem - an MFD-Based Optimization Approach, pp. 733-738

Georgantas, Antonios — University of Cyprus
Menelaou, Charalambos — University of Cyprus
Timotheou, Stelios — University of Cyprus
Panayiotou, Christos — University of Cyprus

This paper deals with the morning commute problem when two classes of commuters co-exist in an urban transportation network. While

each school starts at the same time, traffic flow enters the network simultaneously, leading to the formation of a peak demand value that the network cannot fully accommodate. The task becomes more challenging when commuters head to their workplace after reaching their respective school. To tackle this issue, we propose the School Demand Allocation Paradigm (SDAP), which allows schools to have different starting times. Subsequently, we deploy an optimization framework, the target of which is to determine the optimal pair of the shifted school start time for each school that maintains operation under free-flow conditions. We utilize a macroscopic MFD-based traffic model, which can account for the coupling of the classes mentioned above. The effectiveness of the proposed approach is verified through macroscopic simulations.

14:20-14:40 WeB2.2

Decentralized and Compositional Interconnection Topology Synthesis for Linear Networked Systems, pp. 739-744

Welikala, Shirantha University of Notre Dame
Lin, Hai University of Notre Dame
Antsaklis, Panos J. University of Notre Dame

We consider networked systems comprised of interconnected sets of linear subsystems and propose a decentralized and compositional approach to stabilize or dissipativate such linear networked systems via optimally modifying some existing interconnections and/or creating entirely new interconnections. We also extend this interconnection topology synthesis approach to ensure the ability to stabilize or dissipativate such networks under distributed (local) feedback control. To the best of the authors' knowledge, this is the first work that attempts to address the optimal interconnection topology synthesis problem for general linear networked systems. The proposed approach only involves solving a sequence of linear matrix inequality problems (one at each subsystem), and thus, it can be implemented efficiently and scalably in a decentralized and compositional manner. We also include a case study where the proposed interconnection topology synthesis approach is compared with an alternative dissipativity-based approach.

14:40-15:00 WeB2.3

Modeling and Control of a Hybrid PV-T Collector Using Machine Learning, pp. 745-750

Ul Abdin, Zain University of Picardy Jules Verne
Rachid, Ahmed University of Picardy Jules Verne

Photovoltaic-thermal (PV-T) systems are expected to fulfil an increasingly vital role in future energy production. The current research endeavors to showcase machine learning modeling and control of a water-based PV-T collector. In this work, the PV-T collector is modeled using a decision tree algorithm and artificial neural network (ANN). The predicted outputs are compared with the actual outputs to validate the models. The ANN-based model performed better and proved its efficacy in training and testing. Further, various control strategies are implemented and their performance is compared. All the techniques presented are illustrated through simulation results.

15:00-15:20 WeB2.4

Fictitious Reference Iterative Tuning of Intelligent Proportional-Integral Controllers for Tower Crane Systems, pp. 751-757

Roman, Raul-Cristian Polytechnic University of Timisoara
Precup, Radu-Emil Polytechnic University of Timisoara
Petriu, Emil University of Ottawa
Muntyan, Mihai Polytechnic University of Timisoara
Hedrea, Elena-Lorena Polytechnic University of Timisoara

The current paper introduces a hybrid data-driven control algorithm obtained by the mix of two data-driven algorithms, namely intelligent proportional-integral controllers as representative Model-Free Control (MFC) algorithms, whose parameters are optimally tuned via Fictitious Reference Iterative Tuning (FRIT) algorithms using metaheuristic Slime Mould Algorithm. The purpose of the current mix is to combine the advantages of MFC and FRIT. The efficiency of the novel data-driven algorithms is proved using real-time experiments by controlling the 3 degrees of freedom tower crane system equipment.

15:20-15:40 WeB2.5

Fractional-Order Dynamics in Large Scale Control Systems, pp. 758-763

Goodwine, Bill University of Notre Dame

Fractional-order differential equations are increasingly used to model systems in engineering for purposes such as control and health-monitoring. Because of the nature of a fractional derivative, mechanistically fractional-order dynamics will most naturally arise when there are non-local features in the dynamics. Even if there are no non-local effects, however, when searching for an approximate model for a very high order system, it is worth considering whether a fractional-order model is better than an integer-order model. This work is motivated by the challenges presented by very large scale systems, which will be increasingly common as integration of the control of formerly decoupled systems occurs such as in cyber-physical systems. Because fractional-order differential equations are more difficult to numerically compute, justifying the use of a fractional-order model is a balance between accuracy of the approximation and ease of computation. This paper constructs large, random networks and compares the accuracy of integer-order and fractional-order models for their dynamics. Over the range of parameter values considered, fractional-order models generally provide a more accurate approximation to the response of the system than integer order models. To ensure a fair comparison, both the fractional-order and integer-order models considered had two parameters.

15:40-16:00 WeB2.6

Predicting Opinions in Social Networks Using Recurrent Neural Networks, pp. 764-769

Zareer, Mohamed Mohamed Zareer
Selmic, Rastko Concordia University

This paper studies the spread of opinions in social media networks through the lens of opinion dynamics. As more human interactions and public discourse move online, understanding opinion formation and evolution in social media is crucial for issues such as virtual marketing, information dissemination, and social security. We introduce a novel approach using recurrent neural networks (RNN) to monitor and predict interactions in these networks. Our method uses two configurations of RNN algorithms to predict the opinions of agents in an online social network, with results showing its effectiveness in predicting diverse opinions. The first configuration uses a

sigmoid activation function to predict the binary opinions output (agree, disagree), while the second configuration uses the softmax function to predict more detailed opinions. For the simulation results, we considered a group of five agents interacting in the Twitter network on the subject of COVID-19. The social interaction for a 30-day period was captured and opinion dynamics prediction using the RNN was verified.

WeB3	Grand Hall C
Nonlinear Control (II) (Regular Session)	
Chair: Ferrentino, Enrico	University of Salerno
Co-Chair: Fotiadis, Filippos	Georgia Institute of Technology

14:00-14:20 WeB3.1

Discrete Fully Probabilistic Design: Towards a Control Pipeline for the Synthesis of Policies from Examples, pp. 770-775

Ferrentino, Enrico — University of Salerno
Chiacchio, Pasquale — University of Salerno
Russo, Giovanni — University of Salerno

We present the principled design of a control pipeline for the synthesis of policies from examples data. The pipeline, based on a discretized design, expounds the algorithm introduced in [1] to synthesize policies from examples for constrained, stochastic and nonlinear systems. The pipeline: (i) does not need the constraints to be fulfilled in the possibly noisy example data; (ii) enables control synthesis even when the data are collected from an example system that is different from the one under control. The design is benchmarked on an example that involves controlling an inverted pendulum with actuation constraints. The data that are used to synthesize the policy are collected from a pendulum that: (i) is different from the one under control; (ii) does not satisfy the actuation constraints.

14:20-14:40 WeB3.2

Achieving Prescribed Performance for Uncertain Impulsive Systems in Brunovsky Canonical Form, pp. 776-781

Kechagias, Andreas — Aristotle University of Thessaloniki
Rovithakis, George A. — Aristotle University of Thessaloniki

In this work we consider uncertain impulsive systems in Brunovsky canonical form with possibly aperiodic impulses. Following the prescribed performance control methodology, a state feedback controller is designed to guarantee that between any two consecutive impulses, the output tracking error will converge to a neighborhood of zero of predefined size, in no greater than a user selected fixed-time. In addition, all signals in the closed-loop are bounded. Simulations clarify and verify the approach.

14:40-15:00 WeB3.3

Construction of Control Lyapunov Function with Region of Attraction Using Union Theorem in Sum-Of-Squares Optimization, pp. 782-787

Biswas, Bhaskar — Cranfield University
Ignatyev, Dmitry — Cranfield University
Zolotas, Argyrios — Cranfield University
Tsourdos, Antonios — Cranfield University

Control Lyapunov function (CLF) paves the way for designing a certified controller with a known stable region, which is the out-most importance in control systems. Sum-of-Squares (SOS) optimization is one method to construct the CLF with this stable region known as a region of attraction (ROA). However, existing methods yield quite conservative results. A new approach for constructing CLF overcoming existing limitations is proposed in this paper. The proposed method is based on the Union Theorem in sum-of-squares optimization, which enables the application of more than one variable size region generated by positive functions known as the Shape Function. Numerical simulations demonstrate the effectiveness of the proposed method, which outperforms the existing methods and provides a significantly enhanced ROA.

15:00-15:20 WeB3.4

Input-Constrained Prescribed Performance Control for SISO Nonlinear Systems Via Reference Relaxation, pp. 788-793

Fotiadis, Filippos — Georgia Institute of Technology
Rovithakis, George A. — Aristotle University of Thessaloniki

For a class of uncertain, single-input single-output (SISO) nonlinear systems, we consider the problem of prescribed performance tracking control under strict control input constraints. By prescribed performance, we mean that the system's output should track a given reference signal, with an error confined within a user-prespecified time-varying envelope. The desired reference signal is also predefined by the user; however, when input saturation occurs, it is temporarily modified so that the tracking task becomes feasible given the provided level of saturation. With the proposed approach, it is proved that if the saturation level exceeds a given threshold that we explicitly quantify, then all closed-loop signals remain bounded and the desired reference can be tracked with arbitrary precision. Simulations verify and clarify theoretical results.

15:20-15:40 WeB3.5

Discrete-Time Gradient Systems Governed by Difference Equation with Minima, pp. 794-799

Prasun, Parijat — Indian Institute of Technology, Varanasi
Pandey, Sunidhi — Indian Institute of Technology, Varanasi
Kamal, Shyam — Indian Institute of Technology, Varanasi
Ghosh, Sandip — Indian Institute of Technology, Varanasi
Singh, Devender — Indian Institute of Technology, Varanasi

This article explores the theory of discrete-time gradient systems that converge in a finite amount of time and are governed by a difference equation with minima. Two algorithms with distinct structures are discussed, both aimed at achieving finite-time stabilization of these systems. These gradient-based algorithms have significant applications in solving optimization problems. Using the finite-time convergent techniques discussed in the article, a quadratic programming problem is solved, and an optimal solution is obtained within a finite time frame. The effectiveness of these proposed methods is demonstrated through simulation results.

WeB4	Telfkros
Linear Systems (Regular Session)	
Chair: Nguyen, Ba Huy	Institute for Problems in Mechanical Engineering of the Russian Academy of Sciences
Co-Chair: Konovalov, Dmitry	ITMO University

14:00-14:20 WeB4.1

Extended Adaptive Observer for Linear Systems with Overparameterization, pp. 800-805

Glushchenko, Anton — V. A. Trapeznikov Institute of Control Sciences
Lastochkin, Konstantin — V. A. Trapeznikov Institute of Control Sciences

Exponentially stable extended adaptive observer is proposed for a class of linear time-invariant systems with unknown parameters and overparameterization. It allows one to reconstruct unmeasured states and bounded external disturbance produced by a known linear exosystem with unknown initial conditions if a weak requirement of regressor finite excitation is met. In contrast to the existing solutions, the proposed observer reconstructs the original (physical) states of the system rather than the virtual one of its observer canonical form. Simulation results to validate the developed theory are presented.

14:20-14:40 WeB4.2

Parameter Estimation-Based Observer for Linear Systems with Polynomial Overparameterization, pp. 806-810

Glushchenko, Anton — V. A. Trapeznikov Institute of Control Sciences
Lastochkin, Konstantin — V. A. Trapeznikov Institute of Control Sciences

An adaptive state observer is proposed for a class of overparametrized uncertain linear time-invariant systems without restrictive requirement of their representation in the observer canonical form. It evolves the method of Generalized Parameters Estimation-Based Observer design and, therefore, (i) does not require to identify Luenberger correction gain parameters, (ii) forms states using algebraic rather than differential equation. Additionally, the developed observer is applicable to systems with unknown output matrix and ensures exponential convergence of unmeasured state observation error under weak requirement of the regressor finite excitation. The effectiveness of the proposed solution is supported by simulation results.

14:40-15:00 WeB4.3

Design Constraints in the Synthesis of Control of Positive Linear Discrete-Time Systems, pp. 811-816

Krokavec, Dusan — Technical University of Kosice
Filasova, Anna — Technical University of Kosice

The linear matrix inequality approach is proposed to state control design of discrete-time linear positive systems, guaranteeing the closed-loop system positiveness, enabling attenuation of the impact of disturbances on the system and, if it is necessary, also giving possibility to mount limiting quadratic constraints on state variables into design conditions. Constructing the set of linear matrix inequalities warranting the strictly positive structure and the Lyapunov inequality forcing quadratic stability of the controlled system, the design conditions outlined and proven are the main results of the paper. The diagonal stabilizability had to be included into the set of linear matrix inequalities to construct the closed-loop schemes with a positive control law gain. The proposed approach is numerically illustrated.

15:00-15:20 WeB4.4

Observer-Based Control MIMO Linear Systems with Providing Output in Given Set, pp. 817-822

Nguyen, Ba Huy — Institute for Problems in Mechanical Engineering, RAS
Hoang, Anh Phuong — ITMO University
Phung, Van Quy — ITMO University

The paper proposes a method for synthesizing the control of linear plants with a guarantee of finding the controlled variable in a given set under the condition that only the system output is measurable. In this work, the output feedback control is not used because of its complexity of synthesis, but the observer-based control using the Luenberger observer is used. A change of coordinates is applied to transfer the original problem with output constraints to a problem of control by an auxiliary variable without constraints. The controller's adjustable parameter is selected from the solution of linear matrix inequalities, which enhances the practical applicability of the proposed method. Numerical simulations using Matlab confirm the effectiveness of the proposed method by demonstrating the boundedness of all signals in the control system and the presence of controlled signals within the given set.

15:20-15:40 WeB4.5

Finite-Time Observer Design for Linear Descriptor Systems, pp. 823-828

Konovalov, Dmitry — ITMO University
Zimenko, Konstantin — ITMO University
Kremlev, Artem — ITMO University
Margun, Alexey — ITMO University
Dobriborsci, Dmitrii — Deggendorf Institute of Technology
Aumer, Wolfgang — Deggendorf Institute of Technology

The paper is devoted to the problem of finite-time observer design for linear descriptor systems. The scheme of observer parameters selection is presented by linear matrix equations and inequalities. The proposed observer does not require system transformation to a canonical form and guarantees convergence of the observation error to zero in a finite time.

WeB5	Evagoras
Multi-Agent Systems (Regular Session)	
Chair: Wang, Wei	KTH Royal Institute of Technology in Stockholm
Co-Chair: Wang, Zeyuan	University of Paris-Saclay

14:00-14:20 WeB5.1

Improved Dynamic Event-Triggered Consensus Control for Multi-Agent Systems with Designable Inter-Event Time, pp. 829-834

Wang, Zeyuan — University of Paris-Saclay
Chadli, M. — University of Paris-Saclay

This paper considers the leader-following consensus control for linear multi-agent systems. Two improved dynamic event-triggered control frameworks are proposed. The first is based on a moving average approach, whereas the second is a fully-distributed control scheme based on a well-chosen Lyapunov function with rigorous proof of adjustable inter-event time. The proposed methods involve model-based estimation and clock-like auxiliary dynamic variables to eventually increase the inter-event time as long as possible. Compared to the static event-triggered strategy and the existing state-of-the-art dynamic event-triggered mechanism, the proposed approach significantly reduces the communication frequency while guaranteeing asymptotic convergence. Numerical simulations demonstrate the validity of the proposed theoretical results.

14:20-14:40 WeB5.2

Modifying Neural Networks in Adversarial Agents of Multi-Agent Reinforcement Learning Systems, pp. 835-840

Elhami Fard, Neshat — Concordia University
Selmic, Rastko — Concordia University

This paper proposes a method to reduce the malicious agent's negative effects on a multi-agent reinforcement learning (MARL) system, including actor-critic architecture. The method achieves the overall goal of the MARL system, which is to increase the cumulative reward of all individual agents and reduce the malicious agents' harmful effects on the entire MARL system. Assuming that the adverse agent is detectable, we propose to change the malicious agent's neural network (NN) structure. By leveraging a comparative methodology, we have demonstrated that a specific NN architecture using a linear activation function surpasses another utilizing a sigmoid activation function in minimizing loss. Our analysis indicates that this performance differential is attributable to the utilization of distinct activation functions within the models. This approach involves calculating the gradient of the loss function with respect to the activation function. The claims have been proven theoretically, and the simulation confirms theoretical findings.

14:40-15:00 WeB5.3

Distributed Event-Triggered Leader-Follower Consensus of Nonlinear Multi-Agent Systems, pp. 841-846

Marchand, Mathieu — ONERA
Andrieu, Vincent — University of Lyon
Bertrand, Sylvain — ONERA
Piet-Lahanier, Hélène — ONERA

We consider the distributed leader-follower consensus problem with event-triggered communications. The system under consideration is a non-linear input-affine multi agent system. The agents are assumed to have identical dynamics structure with uncertain parameters and satisfying an incremental stabilisability condition. A distributed control law is proposed which achieves consensus based on two novel Communication Triggering Conditions (CTCs): the first one to achieve an asymptotic consensus but without any guarantees on Zeno behaviour and the second one to exclude Zeno behaviour but with practical consensus.

15:00-15:20 WeB5.4

Platoons Coordination Based on Decentralized Higher Order Barrier Certificates, pp. 847-852

Sharifi, Maryam — ABB Corporate Research
Dimarogonas, Dimos V. — KTH Royal Institute of Technology

This paper presents control strategies based on timevarying convergent higher order control barrier functions for the coordination of networks of platoons. This network could be modelled by a class of leader-follower multi-agent systems, where the leaders have knowledge on the associated tasks and control the performance of their platoon involved vehicles. The followers are not aware of the tasks, and do not have any control authority to reach them. They follow their platoon leader commands for the task satisfaction. Signal temporal logic (STL) tasks are defined for the platoons coordination. Robust solutions for the task satisfaction, based on the leader's accessibility to the follower vehicles' states are suggested. In addition, using the notion of higher order barrier functions, decentralized barrier certificates for each vehicle evolving in a formation dynamic structure are proposed. Our approach finds solutions to guarantee the satisfaction of STL tasks independent of the agents' initial conditions.

15:20-15:40 WeB5.5

Decentralized Multi-Agent Coordination under MITL Specifications and Communication Constraints, pp. 853-860

Wang, Wei — KTH Royal Institute of Technology
Schuppe, Georg — KTH Royal Institute of Technology
Tumova, Jana — KTH Royal Institute of Technology

We propose a decentralized solution for high-level multi-agent task planning problems in environments considering communication network failure. In particular, we consider that robots can only sense each other and communicate within a limited radius, yet, they may

need to collaborate to accomplish their tasks. These tasks are given in Metric Interval Temporal Logic (MITL), which is capable to capture complex task specifications involving explicit time constraints. To substitute for the lacking communication networks, we deploy an agile robot (e.g., drones) to transfer information between the heavy-duty robots while executing tasks. We propose an algorithm to decompose each MITL formula that is assigned to the corresponding heavy-duty robot into an independent task of that robot and an independent request for others. The agile robot systematically pursues heavy-duty robots to exchange requests. The heavy-duty robots use formal methods-based algorithms to compute path plans satisfying the independent promises and the received requests. While the robots' plan computation is fully decentralized, the satisfaction of all tasks is guaranteed (if such plans are found). The proposed solution can be applied to practical applications where the communication network fails or is restricted, such as post-catastrophe search and rescue and wildlife surveillance.

15:40-16:00 WeB5.6

Improved Simultaneous Perturbation Stochastic Approximation-Based Consensus Algorithm for Tracking, pp. 861-866

Erofeeva, Victoria Institute for Problems in Mechanical Engineering, RAS
Granichin, Oleg Saint Petersburg State University

In this paper, we consider a distributed stochastic optimization problem where the goal is to cooperatively minimize a non-stationary mean-risk functional. Such problem is an integral part of many important problems in wireless networks, transportation systems, sensor networks, and others. In particular, we focus on the reduction of computational effort needed to achieve a certain level of accuracy. Thus, we propose an improved Simultaneous Perturbation Stochastic Approximation-based consensus algorithm that achieves better accuracy in contrast to an existing solution over the same time horizon and provide its theoretical analysis. We also show the convergence to a bound for mean-squared errors of estimates. The simulation validates the new algorithm in a multi-sensor multi-target problem.

ThA1 Grand Hall A

Adaptive Control (Regular Session)

Chair: Horn, Joachim — Helmut-Schmidt-University / University of the Federal Armed Forces Hamburg

Co-Chair: Schwung, Andreas — Fachhochschule Südwestfalen

10:30-10:50 ThA1.1

Adaptive Compensation Disturbance for Linear Systems with Input Delay, pp. 867-872

Nguyen, Khac Tung — ITMO University
Vlasov, Sergey — ITMO University
Dobriborsci, Dmitrii — Deggendorf Institute of Technology
Pyrkin, Anton — ITMO University

An adaptive algorithm, compensating for unknown harmonic disturbance acting for linear objects under conditions of the unavailable state vector with a defined delay in the control channel is proposed. One of the features of the proposed method in comparison with other methods is that the perturbation signal is considered in the form of products of sinusoids. A new approach is proposed for estimating the frequencies of harmonic signal. It is assumed that all parameters of the multiharmonic disturbance (amplitude, frequency, and phase) are unknown. The task is completed in several steps. First, an observer is constructed based on a frequency estimation scheme. Secondly, stabilization of the ouput of object to zero is carried out using feedback based on the predictor. Examples are given that confirm the relevance of the proposed approach. Our main contribution is to propose a new scheme for compensating external disturbances for a linear plant and a new approach for estimating the frequencies of a multisinusoidal signal.

10:50-11:10 ThA1.2

Neural Network-Based Control for Affine Formation Maneuver of Multi-Agent Systems with External Disturbances, pp. 873-878

Maaruf, Muhammad — King Fahd University of Petroleum and Minerals
Sami, El-ferik — King Fahd University of Petroleum and Minerals
AL-Sunni, Fouad — King Fahd University of Petroleum and Minerals

This article proposes a distributed control law with a neural network to achieve leader-follower affine formation maneuver (AFM) of multi-agent systems (MASs) subjected to time-varying external disturbances. The leaders determine the desired collective formation maneuvering such as scaling, shearing, translation, and rotation. The distributed controller ensures that the followers are tracking the maneuvers of the leaders at all times despite the disturbances. The disturbances are approximated and compensated with the aid of neural networks. A Lyapunov candidate function is used to highlight that the closed-loop system is uniformly ultimately bounded. Finally, in order to validate the proposed control method, it is applied to a multi-agent system of quadrotors. The simulation results have shown that the proposed control protocol is able to maintain the collective maneuvering of the quadrotors in the presence of time-varying disturbances.

11:10-11:30 ThA1.3

Adaptive Speed Control of ROVs with Experimental Results from an Aquaculture Net Pen Inspection Operation, pp. 879-886

Ohrem, Sveinung Johan — SINTEF Ocean
Evjemo, Linn Danielsen — SINTEF Ocean
Haugaløkken, Bent Oddvar Arnesen — SINTEF Ocean
Amundsen, Herman Biørn — Norwegian University of Science and Technology
Kelasidi, Eleni — SINTEF Ocean

Remotely operated vehicles (ROVs) are often used for inspection in aquaculture net pens which serves the important purpose of localizing holes in the net and reporting potential irregularities and damages. Manual control of the vehicle inside a net pen, while simultaneously inspecting the net structure, is difficult and puts a lot of stress on the vehicle operators. Adaptation of new solutions that enables autonomous traversal of net pens where the vehicle maintains a fixed distance, heading, and velocity relative to the net is considered essential. One of the main challenges of such autonomous solutions is a robust and tight control of the vehicle's velocities. To target this challenge, this paper presents adaptive speed controllers for the surge and sway speeds of a remotely operated vehicle with unknown parameters and under the influence of unknown external disturbances. The stability properties of the controllers are proven through Lyapunov theory, and both simulations and field experiments demonstrate their ability to track the desired speeds through the use of a net following scheme.

11:30-11:50 ThA1.4

Adaptive Optimal Control of Heterogeneous Vehicle Platoons with Bidirectional Communication and Uncertain Dynamics, pp. 887-893

Gaagai, Ramzi — Helmut Schmidt University
Seeland, Felix — Helmut Schmidt University
Horn, Joachim — Helmut Schmidt University

Controlling platoons of heterogeneous vehicles is a relevant field of research. In terms of platoon architecture, many approaches to harness inter-vehicle communication to develop cooperative adaptive cruise control (CACC) systems have been investigated. For instance, optimal control has proven to yield high performance results. Yet, heterogeneity in vehicle dynamics over a platoon poses many challenges. For real world application, one major issue is the uncertainty of model parameters. Furthermore, differences in lagged response to a control input degrade performance criteria such as tracking and cohesion of a vehicle string. Adjusting the spacing with both the preceding and the succeeding vehicles using bidirectional communication can potentially improve the platoon cohesiveness

and is crucial when considering the synchronized merging scenario. In this paper, an adaptive optimal controller is presented which relies on bidirectional platoon communication and deals with parameter uncertainties. Along with the adaptive optimal controller synthesis and string stability analysis, effectiveness of the controller is verified in a simulation example.

11:50-12:10 ThA1.5

Model Predictive Control with Adaptive PLC-Based Policy on Low Dimensional State Representation for Industrial Applications, pp. 894-900

Yuwono, Steve — South Westphalia University of Applied Sciences
Schwung, Andreas — South Westphalia University of Applied Sciences

In the modern era of manufacturing automation, the integration of sensor technology into the system ensures that data acquisition and analysis from complex systems become more efficient than ever. With the support of such developments, artificial intelligence-powered control in industrial control domains gains popularity and the traditional human-based PLC control, where the machines can monitor themselves, learn from the experience, and make their own decisions. However, despite advances in sensor technologies, most of the sensors in industries have limitations in observing the current status of the system, which is mostly limited to Boolean output data instead of continuous output. Therefore, such limitation forms a low dimensional state representation of the system, which could be problematic to develop a self-control policy, e.g. using a model-free deep reinforcement learning. In this paper, we present an effective model predictive controller with adaptive PLC-based policy on low dimensional state representation specifically for industrial control domains. First, we learn the model of the production system using the deep learning method, in case the digital twin is not available. Second, we set up a native implementation of model predictive control. Third, we augment the model predictive control with adaptive PLC-based policy. The proposed method is implemented into a bulk good system showing its potential to self-optimize the system by satisfying the production objective without overflow and low power consumption.

12:10-12:30 ThA1.6

Robust Compensation of External Disturbances for a Class of Linear Systems with State-Delay, pp. 901-906

Bui, Van Huan — ITMO University
Margun, Alexey — ITMO University
Kremlev, Artem — ITMO University
Dobriborsci, Dmitrii — Deggendorf Institute of Technology

The problem of unknown external disturbances compensation for a class of linear systems with an unmeasured and delayed state is considered. The proposed solution is based on the use of the internal model principle and the extended error adaptation algorithm. It is assumed that the disturbance is the output of an autonomous linear generator with unknown parameters. A special observer is constructed to estimate the disturbance. The proposed approach does not require identification of the disturbance parameters. It is shown that in the presence of any state delay, the control algorithm preserves the stability of the closed-loop system. The performance of the obtained result is confirmed using computer simulation.

ThA2 Grand Hall B

Predictive Control (Regular Session)

Chair: Svec, Marko — University of Zagreb, Faculty of Electrical Engineering and Computing

Co-Chair: Voulgaris, Petros — University of Nevada

10:30-10:50 ThA2.1

Model Predictive Control for Path Following and Collision-Avoidance of Autonomous Ships in Inland Waterways, pp. 907-914

Mahipala, Dhanika — Norwegian University of Science and Technology
Johansen, Tor Arne — Norwegian University of Science and Technology

While existing algorithms for open water navigation typically address path following and COLREGS compliant collision-avoidance, the unique challenges of inland waterways require a more tailored approach. We propose a two-level control strategy that employs Model Predictive Control (MPC) and Scenario-Based Model Predictive Control (SB-MPC) for path following and collision-avoidance. The algorithm proposes integrated strategies for handling riparian land, static obstacles, and dynamic obstacles. The method is tested in simulation.

10:50-11:10 ThA2.2

Encrypted Model Predictive Control of Nonlinear Systems, pp. 915-922

Suryavanshi, Atharva Vijay — University of California, Los Angeles
Alnajdi, Aisha Musaad — University of California, Los Angeles
Alhajeri, Mohammed Saeed — Kuwait University
Abdullah, Fahim — University of California, Los Angeles
Christofides, Panagiotis D. — University of California, Los Angeles

In recent years, cyber-security of networked control systems has become crucial, as these systems are vulnerable to targeted cyber-attacks that compromise the stability, integrity and safety of these systems. In this work, secure and private communication links are established between sensor-controller and controller-actuator elements using semi-homomorphic encryption to ensure cyber-security in Model Predictive Control (MPC) of nonlinear systems. Specifically, Paillier Cryptosystem is implemented for encryption-decryption operations in the communication links. Cryptosystems, in general, work on a subset of integers. As a direct consequence of this nature of encryption algorithms, quantization errors arise in the closed-loop MPC of non-linear systems. Thus, the closed-loop encrypted MPC is designed with a certain degree of robustness to the quantization errors. Furthermore, the trade-off between the accuracy of the encrypted MPC and the computational cost is discussed. Finally, a two-state multi-input multi-output continuous stirred tank reactor (CSTR) example is presented to demonstrate the implementation of the proposed encrypted MPC design.

11:10-11:30 ThA2.3

Partially-Connected Recurrent Neural Network Model Generalization Error: Application to Model Predictive Control of Nonlinear Processes, pp. 923-930

Alhajeri, Mohammed Saeed — Kuwait University
Alnajdi, Aisha Musaad — University of California, Los Angeles
Abdullah, Fahim — University of California, Los Angeles
Christofides, Panagiotis D. — University of California, Los Angeles

In recent years, modeling of nonlinear systems has increasingly involved machine learning (ML). Recurrent neural networks (RNNs), a type of supervised learning technique, have shown to be effective in modeling time series data. Particularly, it has been demonstrated in several works that physics-informed RNN models (where the network structure is informed by the pattern of interactions of physical process variables) are preferable to dense RNN models. Motivated by this, the present work focuses on the generalization error of partially-connected RNN models and its relationship to the corresponding error of fully-connected RNN models for the same training and testing data sets. The RNN models are subsequently used in model predictive control of nonlinear processes. Through the use of a chemical process example, the advantages of the use of partially connected RNN models in MPC are illustrated via open-loop and closed-loop simulations.

11:30-11:50 ThA2.4

Testing Nonlinear Predictive Torque Vectoring on a Scaled Car Driving on a Roadway Simulator, pp. 931-936

Svec, Marko — University of Zagreb
Kir Hromatko, Josip — University of Zagreb
Iles, Sandor — University of Zagreb

This paper presents an implementation of a nonlinear model predictive control algorithm for autonomous driving applications. The algorithm is based on a two-track nonlinear model of the vehicle that takes into account Kamm's friction circle and a modified slip definition. It enables all-wheel drive torque vectoring and active front steering. The control algorithm was developed and evaluated through experiments conducted on a scaled four-wheel-drive electric car tested on a treadmill that serves as a roadway simulator. The dSPACE MicroLabBox was used to implement the control algorithm. The algorithm controls both the steering and the torques applied to each wheel based on the desired yaw rate. Its performance was evaluated using double lane change and multiple lane change maneuvers.

11:50-12:10 ThA2.5

Adaptive Risk Sensitive Path Integral for Model Predictive Control Via Reinforcement Learning, pp. 937-942

Yoon, Hyung-Jin — University of Nevada
Tao, Chuyuan — University of Illinois at Urbana-Champaign
Kim, Hunmin — Mercer University
Hovakimyan, Naira — University of Illinois at Urbana-Champaign
Voulgaris, Petros — University of Nevada

We propose a reinforcement learning framework where an agent uses an internal nominal model for stochastic model predictive control (MPC) while compensating for a disturbance. Our work builds on the existing risk-aware optimal control with stochastic differential equations (SDEs) that aims to deal with such disturbance. However, the risk sensitivity and the noise strength of the nominal SDE in the riskaware optimal control are often heuristically chosen. In the proposed framework, the risk-taking policy determines the behavior of the MPC to be risk-seeking (exploration) or riskaverse (exploitation). Specifically, we employ the risk-aware path integral control that can be implemented as a Monte-Carlo (MC) sampling with fast parallel simulations using a GPU. The MC sampling implementations of the MPC have been successful in robotic applications due to their real-time computation capability. The proposed framework that adapts the noise model and the risk sensitivity outperforms the standard model predictive path integral in simulation environments that have disturbances.

12:10-12:30 ThA2.6

Cascaded Disturbance Compensation for MPC-Based Autonomous Vehicle Guidance, pp. 943-948

Jalilian, Arash — IAV GmbH
Schwarz, Norman — Sedenius Engineering GmbH
Völz, Andreas — University of Erlangen–Nuremberg
Ritschel, Robert — IAV GmbH

This paper investigates the task of lateral disturbance compensation based on model predictive control (MPC) for autonomous vehicles. By considering external disturbances and parameter perturbations in the model term of the MPC, the steady-state offset can be compensated. However, in the presence of more dynamic disturbances, like side wind, the lateral path tracking performance deteriorates. To overcome this limitation, a cascaded approach is presented, which is a combination of an MPC-based and an underlying direct compensation. The performance of this approach is validated in simulations as well as in practice with real vehicle tests.

ThA3 — Grand Hall C

Industrial Automation and Manufacturing (Regular Session)

Chair: Leva, Alberto — Politecnico Di Milano
Co-Chair: Fragkoulis, Dimitrios — National and Kapodistrian University of Athens

10:30-10:50 ThA3.1

Safe Operation of a Modular Production System Via Supervisor Automata, pp. 949-956

Koumboulis, Fotis N. — National and Kapodistrian University of Athens
Fragkoulis, Dimitrios — National and Kapodistrian University of Athens

Siake, Benise — National and Kapodistrian University of Athens

In this paper, the three units of a Modular Production System (MPS) benchmark with a parametric number of drilling tools are modelled using finite deterministic automata in the discrete event system framework. The desired behavior of the MPS benchmark process together with the desired sequence of manufacturing actions of the MPS are expressed in the form of specification rules. The rules have been expressed in the form of a set of regular languages. Each regular language has been realized by a supervisor automaton. Using these supervisors, a modular supervisory architecture has been proposed. The physical realizability and the nonblocking property of the controlled automaton have been proved.

10:50-11:10 ThA3.2

Cutting Unequal Rectangular Boards from Cylindrical Logs in Wood Products Manufacturing: A Heuristic Approach, pp. 957-964

Hosseini, Seyed Mohsen — Free University of Bozen-Bolzano
Frego, Marco — University of Trento
Peer, Angelika — Technical University of Munich

In recent years, the global wood products market has become highly competitive. Due to this, sawmills seek to improve their efficiency throughout their production process. In this regard, improving sawing efficiency through improved cutting strategies is vital for preventing overproduction and waste issues. In this paper, we deal with the sawing optimization problem defined as the problem of cutting rectangular boards from cylindrical logs with circular cross sections. In particular, we consider a sawing pattern that is highly beneficial for wood manufacturing, namely cant sawing. We take into account feasibility, capacity, non-overlapping, and technical constraints of the sawing process. We first develop an exact model of this combinatorial optimization problem as a mixed-integer nonlinear programming (MINLP) problem. However, this exact model involves a high level of combinatorics and requires considerable computation time, becoming computationally intractable as the problem size increases. To deal with this challenge, we develop a constructive heuristic approach, namely strip-bottom-left-fill (SBLF) heuristic, that builds a feasible cutting according to a list of ordered rectangles and a set of placement policies. The simulation results confirm the superiority of our proposed approach over the MINLP model and a state-of-the-art heuristic approach in terms of computational effort as well as memory and search requirements while preserving cutting yield efficiency.

11:10-11:30 ThA3.3

Distributed State Estimation for Multi-Area Data Reconciliation, pp. 965-970

Erofeeva, Victoria — Institute for Problems in Mechanical Engineering, RAS
Parsegov, Sergei — Institute of Control Sciences, RAS
Osinenko, Pavel — Skoltech
Kamal, Shyam — Indian Institute of Technology (BHU), Varanasi

Data reconciliation is an essential tool in data processing in various industries. It helps to improve accuracy of decision-making algorithms by reducing the influence of random errors in measurements. In this paper, we consider large-scale data reconciliation problems in which multiple areas communicate over a network to obtain an optimal solution of the centralized problem. Our proposed approach accounts for the boundaries between different areas avoiding a mismatch and sub-optimality as well as reduces computational and communication complexities. The proposed distributed data reconciliation method is compared to a centralized reference in different scenarios.

11:30-11:50 ThA3.4

Automated Cross Channel Temperature Predictions for the PFR Lime Kiln Operating Support, pp. 971-977

Kychkin, Aleksei — Software Competence Center Hagenberg GmbH
Chasparis, Georgios — Software Competence Center Hagenberg GmbH
Ellero, Stefano — Stam S.r.l

The Parallel Flow Regenerative (PFR) lime kiln process is challenging with respect to the energy efficiency, product quality and production stops, due to the inability of the human operators to accurately predict the evolution of the process. Monitoring and controlling of such processes encounter several issues, related to the high mass and heat inertia of the process, data quality, production stops, operator's experience, as well as unknown exogenous factors (e.g., quality of the fuel, and raw material properties). Hence, an automated control/optimization mechanism for properly configuring the process is not straightforward. In this paper, we present a selection of mechanisms for data preprocessing together with domain specific feature analysis that allow for capturing the short-term changes of the critical parameters of the process. Through these mechanisms, automated predictive modeling can be performed that can be used by the kiln operator or a predictive-based controller to modify fuel feed strategies to meet energy efficiency and product quality requirements. We validate the proposed data-based preprocessing and modeling approaches through experiments in real-world data sources

11:50-12:10 ThA3.5

Sensor Selection for High-Dimensional Swarm Systems Based on Observability Analysis, pp. 978-984

Meng, Qingkai — University of Cyprus
Polycarpou, Marios M. — University of Cyprus

The location selection of sensors in large-scale swarm systems is a prerequisite for further design of mechanisms to monitor the system states. This paper considers the required number and location of the sensors in a large-scale swarm system so that the observability of the overall system is satisfied. Firstly, by extending observability theory for swarm systems, some necessary and/or sufficient observability conditions related to the node-dynamics, network topology, coupling mode and measured outputs are obtained. Secondly, based on the above observability conditions, an algorithm for deciding how many and where to place the sensors is designed, which can be implemented in a polynomial complexity time. Finally, an unmanned aerial vehicle (UAV) swarm system is employed to verify the effectiveness of the theoretical results.

12:10-12:30 ThA3.6

Wireless Synchronisation As a Control Problem Embedded in New-Generation Networked Automation Systems, pp. 985-990

Leva, Alberto — Politecnico Di Milano

Terraneo, Federico — Politecnico Di Milano
Fornaciari, William — Politecnico Di Milano

In the present and rapidly evolving industrial scenario, wireless networked controls are gaining importance. This brings about new problems concerning the use of the radio channel, as well as the energy efficiency of the involved devices (often running on battery). We argue that such problems, among which a fundamental one is clock synchronisation, should be addressed by dedicated control structures embedded in the used hardware/software architecture, and that the construction of the said controls should follow strictly system-theoretical principles to the maximum extent. In this paper, building on previous experience, we present such a synchronisation solution together with a formal model for its operation, also accounting for non-idealities in the reference time base. Some experimental results are reported to support the statements made.

ThA4 — Tefkros

Analytical Methods for Control Design and Qualitative Study of Complex Dynamical Systems (Invited Session)

Chair: Sklyar, Grigory — West Pomeranian University of Technology
Co-Chair: Zuyev, Alexander — Otto Von Guericke University Magdeburg
Organizer: Sklyar, Grigory — West Pomeranian University of Technology
Organizer: Zuyev, Alexander — Otto Von Guericke University Magdeburg

10:30-10:50 — ThA4.1

Dynamic Morphing of Trailing-Edge (I), pp. 991-993

Svoboda, Filip — Czech Technical University in Prague
Tomáš, Čenský — Czech Technical University in Prague
Hromcik, Martin — Czech Technical University in Prague

The aim of this study is to examine the effects of dynamic morphing of the trailing-edge. This particular type of aerodynamic lift mechanism brings new opportunities to control lift distribution and thus control an aircraft. Morphing wing concepts are developed for their high efficiency and other benefits. However, this variable geometry can potentially perform even better by using non-stationary aerodynamic effects. In this article, we demonstrate the first results of this novel approach which will be used to investigate further control strategy development.

10:50-11:10 — ThA4.2

On Classical Solutions of the Stabilization Problem for Nonholonomic Systems with Time-Varying Feedback Laws (I), pp. 994-996

Zuyev, Alexander — Otto Von Guericke University Magdeburg
Grushkovskaya, Victoria — Alpen-Adria University of Klagenfurt

We consider the stabilization problem for driftless control-affine systems under the bracket-generating condition. In our previous works, a class of time-varying feedback laws has been constructed to stabilize the equilibrium of a nonholonomic system under rather general controllability condition. The latter stabilization scheme is based on the sampling concept, which is not equivalent to the definition of classical solutions for the corresponding non-autonomous closed-loop system. In the present contribution, we refine the previous results by presenting sufficient conditions for the convergence of classical solutions of the closed-loop system to the equilibrium. These conditions are illustrated with numerical simulations of the Brockett integrator.

11:10-11:30 — ThA4.3

Periodic Optimization of a Hyperbolic Control System with Application to Nonlinear Chemical Reactions (I), pp. 997-999

Yevgenieva, Yevgeniia — Max Planck Institute for Dynamics of Complex Technical Systems
Zuyev, Alexander — Otto Von Guericke University Magdeburg
Benner, Peter — Max Planck Institute for Dynamics of Complex Technical Systems
Seidel-Morgenstern, Andreas — Max Planck Institute for Dynamics of Complex Technical Systems

We study an optimal control problem for a nonlinear hyperbolic equation with boundary input which describes isothermal chemical reactions in a plug flow reactor. The considered optimization problem is analyzed in the class of periodic controls under an isoperimetric constraint. A dimensionless formulation of this isoperimetric problem is derived, and optimality conditions with piecewise constant controls are formulated. The behavior of the cost functional for such bang-bang controls is illustrated by numerical simulations.

11:30-11:50 — ThA4.4

Some Notes on the Asymptotic Behavior of Unbounded Semigroups on the Domain of the Generator, pp. 1000-1004

Sklyar, Grigory — West Pomeranian University of Technology
Polak, Piotr — University of Szczecin
Wasilewski, Bartosz — University of Szczecin

We study the asymptotics of *C_0*-semigroups on the domain of the generator. In particular we analyze the behavior of *|T(t)(A-lambda I)^{-1}|* as time goes to infinity and develop some existing stability results (semi-uniform stability) to the case when the intersection of the spectrum of the generator with the imaginary axis is non-empty. We also give an example of a class of delay differential equations for which our theorem is applicable.

11:50-12:10 — ThA4.5

Exact Observability for a System of Coupled Wave Equations, pp. 1005-1008

Wozniak, Jaroslaw — West Pomeranian University of Technology in Szczecin

The problem of exact observability of a model of elastic-coupled strings is considered. The lack of regular exact observability is noted and required additional smoothness of observed signal is proposed.

12:10-12:30 ThA4.6

Linearizability Problem and Invariants for Multi-Input Non-Autonomous Control Systems, pp. 1009-1014

Sklyar, Jekatierina — West Pomeranian University of Technology
Ignatovich, Svetlana — V.N. Karazin Kharkiv National University
Sklyar, Grigory — West Pomeranian University of Technology

We consider nonlinear multi-input non-autonomous control systems and analyze their invariants analogous to those introduced in *Sklyar K. On mappability of control systems to linear systems with analytic matrices. Systems Control Lett. 134 (2019) 104572*. We show that, compared to single-input systems, new invariants should be introduced. We give a complete set of invariants for one subclass of multi-input non-autonomous systems and propose a method of solving the time-optimal problem for such systems.

ThA5 Evagoras

Biomedical Engineering (Regular Session)

Chair: Toffanin, Chiara — University of Pavia
Co-Chair: Horváth, Gergely — Pázmány Péter Catholic University

10:30-10:50 ThA5.1

Automatic Setup of a Pulse Duplicator Apparatus through a Dither-Free ESC Approach, pp. 1015-1020

Manzoni, Eleonora — University of Padova
Rampazzo, Mirco — University of Padova
Di Micco, Luigi — University of Padova
Susin, Francesca Maria — University of Padova

With the help of in-vitro simulators, it is possible to simulate human physiological conditions to test medical equipment, accelerating innovation cycles and exploring the search for new and efficient solutions. In this paper, we consider the Pulse Duplicator in use at the University of Padova Healing Research Laboratory in Italy, for testing the effectiveness of prosthetic heart valves under realistic cardiac settings. By using a dither-free extremum seeking controller, that uses 1st order least squares fits for gradient estimation, we automatically adjust a fundamental system parameter in real-time, i.e. a system valve closing degree, that ensures a physiological pressure drop to simulate the peripheral resistance to flow in the human systemic circulation.

10:50-11:10 ThA5.2

Quantifying and Comparing the Impact of Combinations of Non-Pharmaceutical Interventions on the Spread of COVID-19, pp. 1021-1026

Horváth, Gergely — Pazmany Peter Catholic University
Szederkényi, Gábor — Pazmany Peter Catholic University
Reguly, István Zoltán — Pazmany Peter Catholic University

In this paper, we quantify the impact of non-pharmaceutical interventions (NPIs) on the spread of COVID - both individually and in various combinations. We utilize the previously developed PanSim agent-based model to accurately capture various aspects of the epidemic and the interventions and show how the transmission rate (β) commonly used in compartmental ODE models can be matched to the agent-based model and used to compare interventions. Through a specific example of targeting a desired level of peak hospitalization, we give several equivalent intervention packages that can be imposed at various times during a single wave to achieve this goal. By mapping out the effect of different combinations of interventions on the transmission rate, we pave the way for coupling the PanSim model with advanced feedback control.

11:10-11:30 ThA5.3

Personalized LSTM-Based Alarm Systems for Hypoglycemia Prevention, pp. 1027-1032

Toffanin, Chiara — University of Pavia
Iacono, Francesca — University of Pavia
Magni, Lalo — University of Pavia

Hypoglycemia prevention is one of the main challenges of an efficient Type 1 diabetes control. Alarm Systems (ASs) that alert the patients about upcoming hypoglycemia are useful instruments to act in advance and avoid it. Model-based ASs use patient models to predict future Blood Glucose (BG) levels and to activate alarms, so model prediction capabilities highly influence the AS performance. In recent studies, neural network techniques for BG forecasting obtained promising results, both as population and personalized models. In particular, Personalized Long Short-Term Memory models (P-LSTMs) for BG predictions obtained good results in literature on the 100 in silico patients of the UVA/Padova simulator. In this work, personalized ASs for hypoglycemia prevention based on P-LSTMs are proposed. The ASs are able to predict correctly the 79% of the hypoglycemia events with a precision of 87%. These performances could be improved for some critical patients that present poor prediction performances. An enhanced version of the P-LSTM is currently under study.

AUTHOR INDEX

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