

TUE 16 JULY

09:00	Breakfast & Registration	
10:00	Machine Learning and Intelligent Control	<p>Dr Edmondo Minisci Intelligent Computational Engineering Laboratory, University of Strathclyde</p> <p>Artificial intelligence (AI) as a field of research and development emerged in parallel with the development of the theory of automatic control, starting after WW2, with the first major applications in computing and information science. Today, both AI and automatic control have reached a level of stability and maturity, which, coupled with the sharp increase in possibilities of computer technology (both hardware and software), can lead to a rethinking of theory and practice of Intelligent Control. IC is again, after a period of neglect linked to various failures and unsuccessful attempts, the answer for control systems that have to ensure their optimality, functional and operational reliability, efficiency, fault tolerance and survivability when: 1) there is a lack of a priori information about the control object and objectives, and external environment, 2) there is a big number of aleatory factors that cannot be taken into account deterministically, and 3) there could be degradation (from failures, accidents) or necessity of targeted reconfiguration. This tutorial will give an overview of IC techniques and approaches in various fields of engineering applications.</p>
11:00	Using Networks for Constellation Responsiveness, Resilience, and Data Routing	<p>Dr Chris Lowe, Dr Ciara McGrath, Dr Ruaridh Clark University of Strathclyde</p> <p>There are a number of obvious reasons for making the change from launching one or two large, highly capable satellites, to instead deploying tens or hundreds of small (perhaps less capable) satellites; increased revisit rate, higher resilience and distributed data collection are but a few. However, the use of mega-constellations also poses challenges, such as higher launch costs and increased orbit congestion. In this tutorial, we investigate the use of graph theoretical techniques to design agile, inter-connected satellite constellations and ask can we do more with less?</p>
12:00	Lunch (1.5 hours)	
13:00		
	Legal aspects of the use of space, space debris and in orbit servicing	<p>Dr Saskia Vermeylen, Law School, University of Strathclyde</p> <p>Despite a well-established <i>Corpus Iurus Spatialis</i> we are lacking binding international law to regulate the environmental impact of human space activities. This tutorial will explore non-binding international initiatives that are currently in use to protect and enhance the safe, secure and sustainable use of outer space. This includes: (i) an analysis of space debris mitigation guidelines and the proposed International Code of Conduct of Outer Space Activities, (ii) legal assessment of remediation strategies, and (iii) ethical considerations for establishing an international treaty for regulating and reducing space debris in outer space.</p>
14:00	30-minute break	
15:00	Practical methods for Multi-Objective Optimal Control	<p>Prof Massimiliano Vasile Aerospace Centre of Excellence, University of Strathclyde</p> <p>Multi-Objective Optimal Control is a relatively recent area of research and development that aims at solving optimal control problems with multiple competing objectives. Solving an MOOC problem is computationally much more complex and expensive than solving a single objective optimal control problem (OCP) but is extremely useful as it provides an optimal trade off among a wide range of alternative solutions. The literature offers a good body of work on most theoretical aspects of MOOCP and a few practical methods for their solution. The tutorial will introduce the MOOCP formulation and the main differences between an MOOCP and a standard optimal control problem. It will then present a couple of practical solution approaches and some theoretical aspects related to the local convergence of one of them. A few examples of applications will conclude the tutorial.</p>
16:00	Networking & Exhibit: Ocean, Air & Space Industrial Expo	
17:00	Level 2, Technology & Innovation Centre (TIC)	

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08:00	Registration		
09:00	Keynote	Prof Simone D'Amico, Stanford University Autonomous guidance, navigation and control for miniaturised distributed space systems	
10:00	Breakfast		
11:00	Session A1 Formation Flying Control	10:30-10:45	Cluster control system Michael Paluszek, Princeton Satellite Systems, USA
		10:45-11:00	Computationally efficient study of highly perturbed spacecraft formation dynamics via approximation Ethan Burnett, University of Colorado, USA
	Chair: Simone D'Amico	11:00-11:15	Spacecraft formation and orbit control using attitude-dependent solar radiation pressure Ethan Burnett, University of Colorado Boulder, USA
		11:15-11:30	Sequentially distributed attitude guidance across a spacecraft formation Mar Cols-Margenet, University of Colorado Boulder, USA
15-minute break			
12:00	Session A2 Formation Flying Control	11:45-12:00	Precise line-of-sight modelling for angles-only relative navigation Gabriella Gaias, Politecnico di Milano, Italy
		12:00-12:15	Navigation of a formation of nanospacecraft at a binary asteroid with TOA and FOA measurements Massimiliano Vasile, University of Strathclyde, UK
	Chair: Jean-Sebastien Ardaens	12:15-12:30	Spacecraft formation feed-forward control via differential drag using relative orbital elements Mohamed Khalil Ben Larbi, TU Braunschweig, Germany
		12:30-12:45	Charge-product control approach to electrostatic leader-follower in LEO plasma wakes Jordan Maxwell, University of Colorado Boulder, USA
		12:45-13:00	Electrostatically actuated deployment for close-proximity leader-follower formation in LEO plasma wakes Jordan Maxwell, University of Colorado Boulder, USA
13:00	Lunch (1.5 hours)		
14:00			
15:00	Session B1 Formation Flying Control & Instrumentation	14:30-14:45	Local information based organization of distributed spacecraft swarm using two-impulse rendezvous Wen Feng, Chinese Academy of Sciences, PR China
		14:45-15:00	Radio interferometry in a heliocentric earth-trailing orbit: A fuel optimal virtual model reference adaptive orbit control approach to a heterogeneous swarm with unknown dynamics Alisa Nevinskaia, TU Delft, Hyperion Technologies, The Netherlands
	Chair: Gabriella Gaias	15:00-15:15	Networked model predictive control for satellite formation flying Damiana Catanoso, Stanford University, USA
		15:15-15:30	Magnetic attitude control for GRACE-like missions Yaroslav Mashtakov, Keldysh Institute of Applied Mathematics of RAS, Russia
15:30-15:45	Proba-3 shadow position sensors subsystem: metrology concept and measurement budget, Davide Loreggia, INAF, Italy		
15-minute break			
16:00	Session B2 Formation Flying Control & Instrumentation	16:00-16:15	Metrology on-board PROBA-3: the shadow position sensors subsystem Vladimiro Noce, INAF, Italy
		16:15-16:30	The in-flight calibration of the shadow position sensors, optical metrology system of the ESA/PROBA-3 formation flying mission Gerardo Capobianco, INAF, Italy
	Chair: Hanspeter Schaub	16:30-16:45	ISL multi-service satellite transceiver for constellation management and formation flying Davide Silva, Space Engineering SpA, Italy
		16:45-17:00	Decentralisation results and sufficient stability conditions for uncoordinated formation and constellation manoeuvres Marcus Holzinger, University of Colorado Boulder, USA
17:00-18:00	Break		
18:00-19:30	Welcome Reception at the Glasgow City Chambers 82 George Square, Glasgow G2 1DU		

THU 18 JULY

08:00	Registration		
09:00	Keynote	Prof Moriba Jah, University of Texas at Austin Impact of Large Constellations on the Space Environment and Related Space Traffic Management	
10:00	Breakfast		
	Session C1 Constellations and Space Traffic Management	10:30-10:45	Towards a future European Space Agency constellation coordination system ESA-CCS operational tool Pedro Jose Jurado Lozano, ESA
		10:45-11:00	Collision risk assessment for the proposed large constellations of satellites during their entire lifecycle Alexis Petit, IFAC-CNR, Italy
11:00	Chair: Moriba Jah	11:00-11:15	Introducing the law games -- predicting legal liability and fault in satellite operations Ralph Dinsley, NORSS, and Christopher Newman, UK
		11:15-11:30	Trade-off study on large constellation de-orbiting with low-thrust and de-orbiting balloons Simeng Huang, Politecnico di Milano, Italy
	15-minute break		
	Session C2 Constellations and Space Traffic Management	11:45-12:00	Spaceflight safety for LEO orbit raising operations Sean Goldsbrough, UK Space Agency
		12:00-12:15	New three dimensional phased array antenna for satellite constellations Nobuyuki Kaya, Wave Arrays, Japan
12:00	Chair: Timothy Maclay	12:15-12:30	Design and practice of global teenagers popular science satellites constellation project Gang Zhang, Beijing SpaceArk Technology Corp. Ltd, PR China
		12:30-12:45	Satellite data for the sustainable development, the scopes and contributions to the environmental condition of developing countries Md Abu Saleh, Rajshahi University of Engineering and Technology, Bangladesh
		12:45-13:00	A UAV-smallsat constellation proposal for augmented remote sensing Kishore Pasi, U R Rao Satellite Centre, India
13:00	Lunch (1.5 hr)		
14:00	Keynote	Dr Timothy Maclay, OneWeb Space Sustainability in the Era of Large-Scale Operations in LEO: What's the Problem?	
15:00	Session D1 Mission Analysis and Design	15:30-15:45	Future satellite constellations and space missions in the context of UKSA licensing and regulation Toby Harris, UK Space Agency
		15:45-16:00	Formation reconfiguration optimisation for the IRASSI space interferometer Luisa Buinhas, Universität der Bundeswehr München, Germany
16:00	Chair: Eric Joffre	16:00-16:15	Analysis of responsive satellite manoeuvres using graph theoretical techniques Ciara McGrath, University of Strathclyde, UK
		16:15-16:30	Proba-3 formation flying mission Damien Galano, ESA
	Session D2 Mission Analysis and Design	16:30-16:45	ITASat-2: The first nanosatellite formation flying Brazilian mission Willer Gomes dos Santos, Instituto Tecnológico de Aeronáutica, Brazil
		16:45-17:00	LISA: heliocentric formation design for the laser interferometer space antenna mission Eric Joffre, Airbus
17:00	Chair: Olivier de Weck	17:00-17:15	Flight results for the formation initialization and control of the HE360 pathfinder mission Niels Roth, University of Toronto, Canada
		17:15-17:30	Investigation of orbital stability around asteroids with automatic domain splitting Jianlang Feng, University of Strathclyde, UK
	Break		
18:30-22:00	Conference Dinner at the Glasgow Science Centre 50 Pacific Quay, Glasgow, G51 1EA		

FRI 19 JULY

08:00	Registration		
09:00	Keynote	Prof Colin McInnes, University of Glasgow Dynamics and Control of Swarms of Chipsats	
10:00	Breakfast		
10:00	Session E1 AI, Machine Learning, Simulation and Optimisation	10:30-10:45	Optimization of low-thrust reconfiguration of formation flying using relaxed stochastic terminal conditions Liqiang Hou, Shanghai Jiaotong University, PR China
		10:45-11:00	Propulsionless planar phasing of small satellites using deep reinforcement learning Brenton Smith, UNSW Canberra, Australia
11:00	Chair: Roberto Furfaro	11:00-11:15	Distributed vision-based multi-target pose estimation for cooperative spacecraft swarms Kai Matsuka, California Institute of Technology, USA
		11:15-11:30	Comparative assessment of image processing algorithms for the pose estimation of uncooperative spacecraft Lorenzo Pasqualetto Cassinis, TU Delft, The Netherlands
15-minute break			
11:00	Session E2 AI, Machine Learning, Simulation and Optimisation	11:45-12:00	Knowledge-based self-reconfiguration and self-aware demonstration for modular satellite assembly Mark Post, University of York, UK
		12:00-12:15	Orbit design of an autonomous space-based SSA swarm: distributed deep learning at the edge Lorraine Weis, L3 Technologies, USA
12:00	Chair: Colin McInnes	12:15-12:30	A self-adaptive magnetic charged system search for time-suboptimal formation flying maneuvers Andrea D'Ambrosio, Sapienza Università di Roma, Italy
		12:30-12:45	Autonomous spacecraft formation flight guidance via ELM-based deep reinforcement learning Roberto Furfaro, University of Arizona, USA
		12:45-13:00	Fast angles-only initial relative orbit determination for onboard application Jean-Sebastien Ardaens, DLR, Germany
		13:00-13:15	Lower bounds on delta-v costs for traveling satellite problems Chandrakanth Venigalla, University of Colorado Boulder, USA
13:00	Lunch (1 hr 15 min)		
14:00	Session F1 Formation Flying Design, Maintenance & Reconfiguration	14:30-14:45	Formation flying reconfiguration manoeuvres via environmental forces in highly elliptical orbits Rebecca La Norcia, Sapienza Università di Roma, Italy
		14:45-15:00	Optimal design of spacecraft formations in Lissajous orbits Sergey Shestakov, Keldysh Institute of Applied Mathematics of RAS, Russia
15:00	Chair: Jiaglang Feng	15:00-15:15	Long term and safe relative orbit design for heterogeneous spacecraft clusters Burak Yaglioglu, Scientific and Technological Research Council of Turkey
		15:15-15:30	A review of satellite constellation reconfiguration and its applications Olivier de Weck, MIT, USA
		15:30-15:45	Maneuvering of spacecraft formations using a linearized lambert algorithm Jay McMahon, University of Colorado Boulder, USA
15-minute break			
16:00	Session F2 Formation Flying Design, Maintenance & Reconfiguration	16:00-16:15	Small satellite formation flying application using the Basilisk astrodynamics software architecture Simon van Overeem, University of Colorado Boulder, USA
		16:15-16:30	Walker constellations and other symmetrical and non-symmetrical constellations in the problem of earth coverage: Theoretical relations and capabilities Yury Razoumny, RUDN University, Russia
		16:30-16:45	Tetrahedron formation maintenance via atmospheric drag control Yaroslav Mashtakov, Keldysh Institute of Applied Mathematics of RAS, Russia
		16:45-17:00	Formation flight relative motion control using solar sail Yaroslav Mashtakov, Keldysh Institute of Applied Mathematics of RAS, Russia
17:00		17:00-17:15	Spacecraft swarm dynamics and control about asteroids Corinne Lippe, Stanford University, USA
		17:15-17:30	Decentralized control of nanosatellites spatial distribution in the swarm in LEO using magnetorquers Danil Ivanov, Keldysh Institute of Applied Mathematics of RAS, Russia
Concluding remarks			