

Artificial Intelligence (AI) for Satellite Systems

Interest in the application of AI in various aspects of society has exploded within the last decade, and the field of satellite systems (and more generally space technologies) is no exception. AI enables optimal decisions and resource management to be achieved within a complex and dynamic space environment. AI facilitates the detection of historical patterns to predict what is likely to happen next (for example solar storms, intense rain events, traffic demand, etc). This is important because it enables the instigation of proactive rather than reactive measures to avoid disruption and ensure service reliability and quality as well as system resilience. In-orbit deployment of AI to extract essential information from the huge amount of raw data collected in space provides the option of transmitting only the most relevant data subset down to earth. This would greatly reduce the amount of signal power and radio spectrum required for data transmission from space to earth, thus enabling us to use space more sustainably and intelligently. These and other benefits and applications of AI in satellite systems (e.g., for ground segment operations and payload design) will be explored in detail along with discussions of related topics of federated learning, edge computing, and distributed satellite systems.



\

This SatNEx School, organised by the Bradford-Renduchintala Centre for Space AI on Tuesday 24th to Thursday 26th October 2023, is focused on the applications of AI in satellite systems. The School brings together highly qualified speakers from industry, research, and academic institutions to discuss emerging applications, computing technologies, and dynamic design/processing techniques relevant to AI in various aspects of satellite systems operation. The content is designed to provide PhD students, early career researchers, and industry professionals with a firm grasp of the start-of-the-art and emerging trends in the subject.

Registered School participants will have the option to attend the [40th ICSSC Colloquium](#) on Direct Satellite to Cellular Mobile Services on Monday 23rd October at a highly reduced student rate. The School program also includes a visit to the facilities of Filtronic, a UK designer and manufacturer of high-performance RF, microwave and mmWave solutions for various markets, including space.

School Date Tuesday 24th Oct 2023 – Thursday 26th Oct 2023

Venue Norcroft Centre, Tumbling Hill Street, University of Bradford,
Bradford, West Yorkshire, United Kingdom, BD7 1DP



Registration <https://www.bradford.ac.uk/ei/research-and-business/bradford-renduchintala-centre/news-events/satnex-school-2023-bradford/>

School Fee £150.00
(Including all tea breaks, lunches, and dinners)

Travel & Accommodation <https://www.bradford.ac.uk/ei/research-and-business/bradford-renduchintala-centre/news-events/satnex-school-2023-bradford/>

AI for Satellite Systems: Programme Overview Day 1 (24 October 2023)

9:00 – 9:25	Registration & Welcome Coffee
9:25 – 9:45	School Opening: Welcome by the SatNEx Team, Miguel Angel Vazquez, Centre Tecnològic de Telecomunicacions de Catalunya Bradford - the City of Culture, CEO of Bradford Council
9:45 – 10:45	Federated Learning in Satellite Systems (Hassan Ugail, University of Bradford)
10:45 – 11:00	Coffee break
11:00 – 12:00	Evolution of AI in Satellite Systems (Tomas Navarro, Future Projects Engineer, ESA)
12:00 – 13:00	AI Enhancement in Satellite Communications (Hector Fenech, Formerly Eutelsat)
13:00 – 14:00	Lunch Break
14:00 – 15:00	AI in Active Electronically Steerable Array (AESA) Antennas for MIMO Satellite Communications (Marco Lisi, Formerly ESA)
15:00 – 16:00	Not Only Image Exploitation: Applications of AI in Satellite Ground Segment (Mario Profili, Head of Ground Segment Systems – Domain Observation and Navigation, Thales Alenia Space)
16:00 – 16:15	Coffee Break
16:15 – 17:15	AI Applications in Satellite Systems (Stephen Laws, Airbus)
17:45– 19:00	Dinner

Day 2 (25 October 2023)

09:00 – 10:00	Applications of AI in EO Data Analytics (David Petit, Head of EO Applications, Deimos Space)
10:00 – 11:00	Applications of AI in Space Mission and Space Weather Events (Rami Qahwaji, University of Bradford)
11:00 – 11:15	Coffee Break
11:15 – 12:15	AI/ML in Fault Discovery and Analysis (Vince Chook, Principal UT Systems Delivery Engineer, OneWeb)
12:15– 13:15	High Bandwidth mmWave Feeder Links for LEO Constellations for Future 5/6G Telecommunications Networks (Tudor Williams, Director of Technology, Filtronic)
13:15 – 14:15	Lunch Break
14:15 – 15:15	How the Experimentation Mindset Fosters Innovation (Yasrine Ibnyahya, Senior Director, Advanced Concepts Technologies, Viasat)
15:15 – 17:15	Company Visit (Filtronic @ Bradford)
17:30 – 19:00	Dinner

Day 3 (26 October 2023)

09:00 – 10:00	Future Concept of Distributed Satellite Systems (Paul Febvre, CTO, Satellite Applications Catapult)
10:00 – 11:00	AI and Edge Computing for 6G NTN (Tomaso deCola Project Manager, DLR)
11:00 – 11:15	Coffee Break
11:15 – 12:15	Intelligent Spacecraft Payload Design (Joseph Atkinson, Independent Consultant)
12:15 – 13:15	Lunch Break
13:15 – 14:30	PocketQube Design Workshop (Viktor Doychinov, Muhammad Ali, University of Bradford)
14:30-14:40	Closing

Organising Committee

Lead Organiser	Prof. Ifiok Otung, Bradford-Renduchintala Centre for Space AI, University of Bradford Ifiok Otung is a Chartered Engineer, Professor of Space Engineering, and Director of the Bradford-Renduchintala Centre for Space AI, University of Bradford, UK. He was formerly Professor of Satellite Communications at the University of South Wales where he established PhD training and research as well as two professionally accredited and highly successful MSc degrees in the subject. Prior to that, he was a Research Fellow at the University of Surrey where his work was focused on satellite link measurements and channel modelling. He holds a PhD in Satellite Communications from the University of Surrey, UK.	 A portrait photograph of Prof. Ifiok Otung, a Black man with short hair, wearing a dark blue button-down shirt, looking directly at the camera.
Local Organisers	Dr Vuong Mai, Dr Viktor Doychinov, Dr Muhammad Ali, Prof. Hassan Ugail, Prof. Rami Qahwaji, Bradford-Renduchintala Centre for Space AI, University of Bradford	
Publicity Organiser	Xiaolei Wang, Bradford-Renduchintala Centre for Space AI, University of Bradford	
Administrator	TBC, Bradford-Renduchintala Centre for Space AI, University of Bradford.	

Abstracts & Speaker Bio

Federated Learning in Satellite Systems	
Time	Day 1: Tuesday 24 October 9:45 –10:45
Abstract	To Follow
Speaker	Hassan Ugail obtained his BSc degree in Mathematics from King's College London in 1995, followed by a PGCE in 1996. He completed his PhD in geometric design at the University of Leeds in 2000 and continued as a post-doctoral researcher at the School of Mathematics there until 2002. Hassan then joined the School of Informatics, University of Bradford, where he is currently a full professor of Visual Computing and the Director of the Centre for Visual Computing at Bradford. His principal research interests include geometric design and visualisation, computer-based physical analysis, design optimisation and machine learning. 

Evolution of AI in Satellite Systems	
Time	Day 1: Tuesday 24 October 11:00 –12:00
Abstract	In the upcoming years, there will be an increased emphasis on advancing Artificial Intelligence (AI) in satellite communications. This is driven not only by the need for enhanced communication and data transfer to support more efficient satellite networks, but also by the requirement to develop, manage, and sustain new satellite systems in a completely different way in order to cope with the demands of future seamless, ubiquitous and integrated satellite-terrestrial communications. Moreover, as AI technology progresses, future satellite communication systems are expected to evolve into more self-reliant, dependable, and efficient systems. This presentation will discuss specific trends in Artificial Intelligence that are to be explored in the upcoming years for enhancing or enabling new SatCom applications. More specifically the presentation will focus on bio-inspired Machine Learning algorithms, Deep learning-assisted Generative Design, advanced Reinforcement Learning algorithms and on-board Continual Learning. The presentation will finally give a broader view on the potential benefits of using these emerging AI technologies for a selected number of SatCom applications.
Speaker	Tomas Navarro is a Future Projects engineer at ESA working on the exploration of new advanced mission concepts and systems for future Satellite Communications systems. He is also responsible for coordinating Artificial Intelligence activities for SatCom applications. Before joining ESA, Tomas worked in the space industry in satellite operations and as an R&D engineer for satellite and payload optimisation systems, focusing on genetic and machine learning algorithms used in operational geostationary communications satellites. Tomas is also the co-inventor of an Artificial Intelligence-powered Space architecture able to improve response times in systems based on a centralised topology. 

AI Enhancement in Satellite Communications	
Time	Day 1: Tuesday 24 October 12:00 – 13:00
Abstract	To Follow
Speaker	Hector Fenech is a Satcom Satellite Payload & Systems Expert with over 40 years in satellite communications. He served as the Director of Future Satellite Systems at Eutelsat between 1989 and 2020, overseeing mission definition for multiple satellites and contract negotiations. Hector has collaborated on various projects with ESA and the EU, focusing on system studies and future satellite systems. He holds a PhD in Information System Engineering from the University of Bradford. He is a fellow of IEEE, a fellow of IET, a fellow of AIAA and a Correspondent of the Air and Space Academy. 

AI in Active Electronically Steerable Array (AESA) Antennas for MIMO Satellite Communications	
Time	Day 1: Tuesday 24 October 14:00 – 15:00
Abstract	To Follow
Speaker	Marco Lisi formerly worked at ESA as Special Advisor in the Navigation Directorate and supported the Executive Director of the European GNSS Agency as Chief Technical Advisor. From 2012 to 2014, he was Special Advisor of the European Commission on European space policies. Marco has worked for more than 35 years in the aerospace, defence, and telecommunications sectors, holding managerial positions in R&D, engineering, and programmes, both in industry and in institutional organizations. Marco has 5 international patents and 200 technical papers. He holds a doctorate in engineering. He is a professor at UNPHU University, Santo Domingo, Dominican Republic. 

Not Only Image Exploitation: Applications of AI in Satellite Ground Segment

Time	Day 1: Tuesday 24 October 15:00 – 16:00	
Abstract	The utilization of artificial intelligence (AI) and deep learning techniques in the support of satellite ground segment operations has gained significant attention in recent years. This lecture aims to provide an extensive overview of the diverse application areas where AI and deep learning are employed in satellite ground segment operations, with a particular focus on earth observation. These applications encompass data analysis and integration, anomaly detection, signal processing, as well as satellite mission planning and multisensory constellation planning. Upon conducting an analysis of the prevailing ground segment operation scheme and identifying areas that would benefit most from AI support in terms of automation, workload optimization, and reduction of human errors, this lecture underscores the substantial potential of AI in optimizing the determination of optimal imaging parameters. Additionally, intelligent scheduling of satellite activities facilitated by AI can lead to enhanced resource utilization, reduced operational costs, and improved overall mission performance. Furthermore, this lecture sheds light on the role that AI can play in planning activities for a multisensory earth observation satellite constellation. Using diverse inputs as analysis of user and service requests, coverage requirements, satellite performances, external support data, or corresponding product analysis, AI algorithms can dynamically propose correlated requests at constellation level or automated fast re-planning schemes, thereby maximizing coverage, reducing latency, and adapting to changing user needs.	
Speaker	Mario Profili is the Head of Ground Segment Systems - Domain Observation and Navigation Italy at THALES ALENIA SPACE, and a Visiting Professor at the University of Bradford. He has more than 20 years of experience in large scale space programmes, spanning from system engineering to Project Management of complex systems with a particular focus on end-to-end system architecture, operations and performance topics. He also has experience in integrated logistic support and maintenance for Space Program.	

AI Applications in Satellite Systems

Time	Day 1: Tuesday 24 October 16:15 – 17:15	
Abstract	To Follow	
Speaker	Stephen Laws is a Satcom System Design Authority at Airbus Defence and Space. Prior to this role, he held various positions at Motorola Solutions within Airbus DS Communications, including Payload Design Manager, Payload Engineering Manager, and RF System Lead. Stephen earned his BEng degree in Electrical, Electronic, and Communications Engineering from the University of Bath, UK.	

Applications of AI in EO Data Analytics	
Time	Day 2: Wednesday 25 October 09:00 – 10:00
Abstract	Over the past decade, Artificial Intelligence has transformed the practices in Earth Observation Data Analytics from a manual task that required expertise in Remote Sensing, Computer Vision and Geographical Information Systems to an automated task that could be performed by users who lacked knowledge about Earth Observation, using only natural language. This transformation was enabled and necessitated by the availability of large quantities of free satellite imagery (Sentinels, Landsat...) and commercial imagery with high resolution and frequency. The transformation occurred in two major phases. In 2015, Convolutional Neural Networks, which were widely used in Computer Vision, were applied to Earth Observation to replace the previous techniques for image classification, segmentation and interpretation. In 2022, Large Language Models were introduced, which altered the practices for image indexing and querying, creating connections between images, text and numbers, and eliminating the need to access satellite imagery to obtain information. However, despite the operational achievements, the sector still faces several challenges that need to be addressed for Earth Observation Analytics to reach its full potential.
Speaker	David Petit is the Head of EO applications at Deimos Space. He has more than 20 years of experience in applications and software development for Earth Observation, Image and Signal processing, involving innovative technologies such as AI (neural networks), GPU, UAV. David obtained a Ph.D. degree in Computer Science and Image Processing from Université Paul Sabatier Toulouse III. 

Application of AI in Rain Fade Mitigation on Satellite Links	
Time	Day 2: Wednesday 25 October 10:00 – 11:00
Abstract	To Follow
Speaker	Rami Qahwaji is a Professor of Visual Computing at the University of Bradford. He has been working with different industries in the fields of satellite/space imaging, remote sensing, digital health and imaging, Biometrics, AI and data visualisation developing intelligent systems in collaboration with NASA, ESA, NHS and different SMEs. Rami attracted millions of pounds in research funding from various UK and European funding agencies. Rami is originally trained as an Electrical Engineer and had MSc in Control and Computer Engineering and PhD in AI and Visual Computing. 

AI/ML in Fault Discovery and Analysis	
Time	Day 2: Wednesday 25 October 11:15 – 12:15
Abstract	To Follow
Speaker	Vince Chook is a Senior Manager - UT Delivery Engineering at OneWeb. He has more than 15 years of Satcom experience in UT, RAN, Core Network and Systems Design. Vince holds an MSc degree in Analogue & Digital IC Design, and a BEng degree in Telecommunications Engineering in Electrical & Electronic Engineering, both from Imperial College London. 

High Bandwidth mmWave Feeder Links for LEO Constellations for Future 5/6G	
Time	Day 2: Wednesday 25 October 12:15– 13:15
Abstract	To Follow
Speaker	Tudor Williams is the director of technology at Filtronic, where he leads technical strategy and develops engineering roadmaps. Before joining Filtronic, Tudor was interim director of technology at the Compound Semiconductor Applications Catapult, where he built a team of skilled engineers and an advanced measurement and characterization facility from scratch. Tudor also worked as engineering manager at Mesuro, a startup company spun out of Cardiff University and sold to Focus Microwave, and as a MMIC design engineer at Selex Sensors and Airborne systems. He has a Ph.D. in RF Engineering from Cardiff University. 

How The Experimentation Mindset Fosters Innovation	
Time	Day 2: Wednesday 25 October 14:15 – 15:15
Abstract	To Follow
Speaker	Yasrine Ibnyahya is a Senior Director of Advanced Concepts and Technologies at Inmarsat. She leads breakthrough innovations, early-stage mission concepts, and start-up and entrepreneurship engagement initiatives. With previous experience at satellite manufacturer SSTL and the French National Space Centre subsidiary CLS, Yasrine brings expertise in project management, satellite design, and user terminal development. She holds an Executive MBA from the University of Cambridge, as well as two Masters of Science degrees in Communication Systems and Signal Processing from the University of Bristol and Telecommunications Engineering from École Nationale Supérieure des Télécommunications in France. 

Future Concept of Distributed Satellite Systems	
Time	Day 3: Thursday 26 October 09:00 – 10:00
Abstract	To Follow
Speaker	Paul Febvre is the Chief Technology Officer at the Satellite Applications Catapult. Paul is responsible for establishing a future vision for the sector and directing the technology strategy for the Catapult. He leads a small team of solutions architects and technologists that work across the Catapult to provide industry support in the creation and realisation of technologically innovative solutions to real world challenges. Paul was previously System Design Authority at Inmarsat for 19 years and a satellite telecommunications research engineer at BT Research Labs for 12 years. 

AI and Edge Computing for 6G NTN	
Time	Day 3: Thursday 26 October 10:00 – 11:00
Abstract	To Follow
Speaker	Tomaso de Cola received a master's degree and a PhD from University of Genoa (Italy) in 2001 and 2010 respectively. He worked from 2002 to 2007 with the Italian Consortium of Telecommunications, University of Genoa Research Unit, as scientist researcher. Since 2008, he has been with DLR, where he has been involved in several projects funded by EU and ESA programs, focusing on different aspects of DVB standards, CCSDS protocols, emergency communications, and testbed design. He is currently leading the integrated satellite systems group at the satellite networks departments, as part of the DLR institute of communications and navigation. 

Intelligent Spacecraft Payload Design	
Time	Day 3: Thursday 26 October 11:15 – 12:15
Abstract	To Follow
Speaker	Joseph Atkinson is a Mechanisms Design Engineer at Blue Origin, USA. He has worked in academia and industry for over 15 years, teaching engineering students, designing spacecraft hardware, developing medical devices, and performing research. 

Pocketcube Design Workshop	
Time	Day 3: Thursday 26 October 13:15 – 14:30
Abstract	To Follow
Speaker	Viktor Doychinov is a Lecturer in Electronics and Software Engineering, Faculty of Engineering and Informatics, University of Bradford. He received an MSc in Spacecraft Technology and Satellite Communications from University College London, and a PhD in Electronic and Electrical Engineering from the University of Leeds. He then spent several years there working as a postdoctoral researcher in the Institute of Robotics, Autonomous Systems, and Sensing. He has worked on a wide range of single- and multi-disciplinary projects, all of which have involved the use of RF and wireless technology in one form or another.  Muhammad Ali is a Post-Doctoral Research Staff at Future Ubiquitous Networks Lab, Faculty of Engineering and Informatics, University of Bradford. He completed his MSc and PhD in Mobile & Satellite Communications from the same university. In 2016, he worked as a Lecturer in Department of Electrical Engineering and Computer Science, University of Bolton. He also worked as lead software developer for a London based software house “Direct2Success” from 2016 to 2018. He has developed a diverse skill set through his involvement in EU/Innovative-UK/Industrial funded projects. His expertise lies in avionics communications/heterogeneous wireless/software-defined networks, artificial intelligence, embedded systems, network security, among others. 