



# AIAA Intelligent Systems Call for Papers

## AIAA Science and Technology Forum and Exposition (SciTech 2024)

8-12 January 2024  
Hyatt Regency, Orlando, FL

**DRAFT PAPER DEADLINE: 25 May 2023**

**SUBMISSIONS:** <https://www.aiaa.org/scitech>

### ORGANIZING COMMITTEE

#### IS Technical Discipline Chair

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### Event synopsis:

Submissions are sought in all areas of application of Intelligent System (IS) technologies and methods to aerospace systems, the verification and validation of these systems, and the education of AIAA membership in the use of IS technologies in aerospace and other technical disciplines. Systems of interest include both military and commercial aerospace systems and those ground systems that are part of test, development, or operations of aerospace systems. Technologies that enable autonomy (i.e. safe and reliable operation with minimal or no human intervention) as well as collaborative human-machine teaming in complex aerospace systems/subsystems are of interest. These include, but are not limited to: autonomous and expert systems; discrete planning/scheduling algorithms; intelligent data/image processing, learning, and adaptation techniques; data fusion and reasoning; and knowledge engineering. The application of such technologies to problems that highlight advanced air mobility, certification, carbon emissions/sustainability, space traffic management, and cislunar operations are of particular interest.

### A. Submission Guidelines

**Please submit 5-page extended abstracts (note joint GNC/IS papers require full draft manuscript not to exceed 25 pages, formatted in accordance with the AIAA SciTech manuscript template) at <https://www.aiaa.org/scitech>.**

All extended abstracts will be evaluated by qualified individuals from industry, academia or government. Reviews will be single-blind, and authors will be provided with written reviewer feedback. Authors are advised to incorporate reviewer comments into their final manuscripts.

- **The Intelligent Systems Best Paper Award will be given to the best overall IS paper submission** (see Section D for selection criteria).
- **Student authors are encouraged to submit their work to the Best Student Paper Competition.** The POC for the Student Paper Competition is Jay Wilhelm ([jwilhelm@ohio.edu](mailto:jwilhelm@ohio.edu)). Finalists will be invited to present their work before the award committee at a special conference session (see eligibility and submission details in Section E and at <https://www.aiaa.org/scitech>).
- **Authors of the best papers presented at the conference will be invited to submit their work to the AIAA Journal of Aerospace Information Systems (JAIS) (<https://arc.aiaa.org/journal/jais>).** We also encourage authors who feel their papers are journal quality to simultaneously submit their papers to AIAA JAIS. The AIAA supports dual conference/journal submission, where the review process for the conference and journal are independent.



To help reviewers provide informed evaluations and constructive comments that will stimulate discussion, each submission should clearly and concisely:

- a. State the key research questions being addressed by the submission
- b. Explain the specific technical challenges addressed by the submission
- c. Provide accurate, relevant, and up-to-date references of previous work/state-of-the-art (please ensure correct formatting/spelling of all works cited and include DOI)
- d. State specific innovations, technical contributions, and acknowledgment of published related works
- e. Present sufficient initial evidence to support proposed ideas including preliminary data, thoroems, illustrations, and examples.
- f. Provide a detailed sketch of deliverables for the final full manuscript submission and conference presentation (e.g. simulations, experiments or analyses to be performed, etc.)

## B. Topic Areas of Interest

See below for additional description of the core IS topic areas and the points of contact for each.

Proposals for special sessions or panel discussions on other important and emerging IS topics of interest are also welcome. Please see <https://www.aiaa.org/scitech> for instructions on proposing special topic sessions (see Section F for instructions on proposing panel discussions).

### I. Adaptive and Intelligent Control Systems

Papers are sought that address innovative approaches to intelligent adaptive control system development. Topics of interest include (alphabetically), but are not limited to, adaptive systems, autonomy, distributed/decentralized adaptive control systems, feedback and feed-forward control systems, hybrid systems, learning systems, linear control systems, model reference adaptive control, multi-agent systems, nonlinear control systems, optimal control systems, parameter estimation, and uncertain dynamical system control, as applied to aerospace systems.

POC: Jay Wilhelm ([jwilhelm@ohio.edu](mailto:jwilhelm@ohio.edu)), Merve Dogan ([dogank@erau.edu](mailto:dogank@erau.edu))

Areas of interest include:

- Adaptive systems
- Learning systems
- Adaptive sampling
- Parameter estimation and sensor data fusion
- Analytical and experimental tools for design and validation
- Model reference adaptive control applications
- Distributed/Decentralized adaptive control
- Networked systems adaptive control
- Nonlinear modeling and control
- Model predictive control applications
- Optimization and optimal control systems
- Verification and validation of adaptive systems
- Multivariable control in aerospace systems

### II. Autonomy

This topic invites papers in the area of autonomy – the quality of a system being self-governing. A system exhibiting autonomy can make decisions and respond to unanticipated conditions without direct human supervision. Aerospace systems with autonomous capabilities may operate more efficiently, reduce human workload, and enable new missions and capabilities. These systems may also exhibit novel failure modes and can be difficult to understand and certify relative to traditional aerospace concepts of reliability and safety. Papers are sought in the general area of aerospace autonomy and in focus topics including decision-making techniques, novel applications of autonomy in aerospace, methods to bound or explain actions taken by an autonomous system, and interactions between autonomous agents.

POC: John Bird ([jjbird@utep.edu](mailto:jjbird@utep.edu)) and Junyi Geng ([jgeng@psu.edu](mailto:jgeng@psu.edu)).

Areas of interest include:

- Autonomy and autonomous systems in aerospace



- Runtime assurance
- Aerospace systems which learn during operation
- Verification and validation of autonomy and autonomous systems
- Autonomous contingency management
- Multi-agent and collaborative systems
- UAS traffic management (UTM)

### III. Cybersecurity in Aerospace Systems [joint with Software and Cybersecurity]

Aerospace systems involve communication and avionics equipment that is susceptible to cyber-attacks that include but are not limited to hacking, jamming, and spoofing. This susceptibility can potentially provide unauthorized remote access to these systems. Incidents of cyber-attacks have occurred, such as hackings of ground-based airline flight planning computer networks and GPS spoofing of military Unmanned Air Systems. Vulnerabilities to cyber-physical systems allowing remote access in ground-based ATC computer networks as well as aircraft cockpit and ground control station systems have been found.

POC: John Valasek ([valasek@tamu.edu](mailto:valasek@tamu.edu)), Jean-Baptiste Jeannin ([jeannin@umich.edu](mailto:jeannin@umich.edu)),  
Jason Kelly ([jason.e.kelly@lmco.com](mailto:jason.e.kelly@lmco.com))

Areas of interest include:

- Methods for control acquisition attack of feedback control systems by false data injection
- Computational intelligent methods and tools to detect hacking, jamming and spoofing of vehicle and ground-based systems or other cyber-physical systems
- Fault detection & isolation methods for monitoring and on-board detection/prevention of deviations from intended operations and other cybersecurity risks or threats for aerospace applications

### IV. Formal Methods in Aerospace Engineering

Modern aircraft contain millions of lines of complex software, much of it performing functions that are critical to safe flight. As an example, the Boeing 787 has over 14 million lines of code! This software must be verified to function correctly with the highest levels of assurance, and aircraft manufacturers must demonstrate evidence of compliance with flight certification requirements like the FAA's DO-178B, DO-178C, DO-333, and DO-254 through a rigorous certification process. Formal methods are being progressively incorporated in the aircraft and spacecraft software design and verification process and are becoming commonplace elements of the aerospace industry. Papers are sought in the field of these formal methods for a wide area of aerospace applications. Additionally, the growing interest in the deployment of increasingly autonomous systems and paths to their verification, validation, and certification for use in safety-critical contexts are of interest to this area.

POC: Han-Lim Choi ([hanlimc@kaist.ac.kr](mailto:hanlimc@kaist.ac.kr)), Natasha Neogi ([natasha.a.neogi@nasa.gov](mailto:natasha.a.neogi@nasa.gov))

Areas of interest include:

- Formal methods for verification
- Formal methods for certification
- Model based development
- Automatic translation
- Compositional reasoning
- Assurance of flight critical system

### V. Guidance, Navigation and Control in Intelligent Systems [joint with GNC]

This joint track co-hosted by the GNC and IS Technical Committees invites papers in the domain of guidance, navigation and control of intelligent, unmanned aerospace systems. In particular, papers that address interactions in unstructured, uncertain and dynamic environments are encouraged. Advancements in conflict resolution and planning under uncertainty, flight control certification and runtime assurance using classical model-based, data driven, learning-based, or hybrid approaches are sought.



Note that submission to this joint track requires adherence to the GNC requirement of a **full draft manuscript**, which must include sufficient detail to allow informed evaluation by the assigned reviewers. Extended abstracts will be returned without review. Full draft manuscripts must not exceed a total length of 25 pages, formatted in accordance with the AIAA SciTech manuscript template.

POC: Hever Moncayo ([moncayoh@erau.edu](mailto:moncayoh@erau.edu)), Jack Langelaan ([jlangelaan@psu.edu](mailto:jlangelaan@psu.edu))

Examples of specific topics include the following:

- Conflict Detection and Resolution: UAS situational awareness and conflict resolution in hybrid and integrated airspaces (UTM), conflict detection methods, sense-and-avoid under uncertainty, sensor/airspace-class specific methods for conflict resolution and collision avoidance,
- Planning in a Dynamic, Uncertain Environment: Multiagent planning and control, integration of decentralized sensing and computation, GPS-denied planning, planning under sensor conflict, dynamic and/or unstructured obstacles, planning in a three-dimensional environment, resource constrained planning, real-time trajectory planning, learning-based planning methods, and intelligent decision making/replanning
- Flight Control Certification: Certification of novel control architectures, intelligent systems, hybrid methodologies, safety metrics,
- Validation and Verification: Correlation issues in V&V, model-based testing, flight validation of high-integrity manned/unmanned aerospace vehicle navigation and control in uncertain and GPS-denied environments, and,
- Human/autonomy interaction: teaming between humans and autonomous systems, effect of human-in-the-loop on operation of intelligent systems, methods for control/supervision of intelligent systems.

#### **VI. Human – Automation Interaction**

This topic seeks papers in the field of human – automation interaction as applied to aerospace systems and vehicle operation and control, robotics, remotely operated vehicles, intelligent agents as teammates, and navigation systems. Topics of interest include research on human trust in automation and how trust affects interactions, how team interactions are affected by automation, and models of effective human-automation interaction/autonomy. Additionally, papers that demonstrate novel applications of human-machine interaction are encouraged.

POC: Justin Bradley [Justin.bradley@unl.edu](mailto:Justin.bradley@unl.edu), Alexander Stimpson [alex.stimpson@vtgdefense.com](mailto:alex.stimpson@vtgdefense.com)

Areas of interest include:

- Human trust in automation
- Automation in team interaction
- Effective human-automation systems
- Human-autonomy interaction
- Mixed-initiative intelligent systems
- Intelligent decision support systems
- Pilot and controller mode awareness
- Cockpit decision aids
- Pilot and controller workload
- Air traffic management automation tools
- Dynamic airspace reconfiguration

#### **VII. Learning, Reasoning, and Data Driven Systems:**

This topic seeks papers in the field of intelligent systems as applied to learning, reasoning, and data driven systems. Aerospace applications include pattern recognition, obstacle detection, localization, and intelligent decision making. Specific research activities include training methods, operations on large datasets, and techniques in learning and reasoning.



POC: Tejas Puranik, [tejas.puranik@gmail.com](mailto:tejas.puranik@gmail.com), Danielle Clement, [danielle.m.clement@lmco.com](mailto:danielle.m.clement@lmco.com);

Areas of interest include:

- Machine vision
- Computer vision (including image processing)
- Artificial Neural Networks
- Evolutionary algorithms
- Quantum computing
- Machine learning and case-based, formal or qualitative reasoning
- Data intensive systems
- Classification methods
- Optimization using Genetic Algorithms (GA)

### **VIII. Probabilistic and Rule-Based Systems**

Papers are sought in the field of probabilistic and rule-based systems as applied to aerospace data, aerospace systems and vehicle operation and control. Probabilistic systems are systems that utilize stochastic processes in the solution and optimization of complex problems, e.g., Recursive Bayesian Estimation (RBE) methods (Kalman, Particle, etc) and Markov Decision Processes. Rule-based systems are systems that utilize crisp and fuzzy logic, biomimicry, and/or self-organization to define adaptive, near-optimal, and robust solutions to complex problems. Motion planning algorithms such as variants of Dijkstra's method are encouraged for publication. Papers that describe novel uses of any combination of the above in aerospace applications are sought. Additionally, papers that demonstrate novel applications of unmanned vehicle systems (including human-vehicle-payload systems) are encouraged.

POC: Liang Sun [lsun@nmsu.edu](mailto:lsun@nmsu.edu) , Junfei Xie [jxie4@sdsu.edu](mailto:jxie4@sdsu.edu)

Areas of interest include:

- Recursive Bayesian Estimation methods (filtering)
- Markov Decision Processes and decision making
- Motion and path planning algorithms
- Fuzzy Logic applied to Aerospace Operation and Control
- Optimization using Market / Auction methods
- Application of Complex Systems paradigms (e.g. self-organization) to Aerospace Operation and Control
- Expert systems based on Crisp, Fuzzy or Crisp-Fuzzy Hybrid Logic
- Bio-inspired systems
- Swarm Optimization methods, e.g. Particle Swarm and Ant Colony Optimization
- Application of Flocking / Swarming rules to the coordination and control of multiple vehicles

### **IX. Sensor Fusion and Systems Health Management (SHM)**

SHM embodies the development of functional capabilities that enable systems to be self-sufficient in determining their current and future operational states. This is accomplished by integrating disparate information from various sources into an overall understanding of the system's health with respect to available resources and operational demand. SHM embodies enabling capabilities for autonomous and semi-autonomous operation which includes fault management, condition-based maintenance (CBM), mission projection/prognosis, failure recovery/response, and life-cycle configuration management. SHM capabilities support the overall system goals of safety for the system, payload, passengers, and public; reusability to reduce development costs; fault tolerance to provide operation in the event of system failures; and verification/certification pathways.

POC: Chetan Kulkarni ([chetan.s.kulkarni@nasa.gov](mailto:chetan.s.kulkarni@nasa.gov)), Bill Maul ([william.a.maul@nasa.gov](mailto:william.a.maul@nasa.gov))

Areas of interest include:



- Fault and Anomaly Detection, Diagnosis, and Prognosis
- SHM Paradigms and Architectures
- Software Tools to Support the Implementation of SHM Capabilities.
- SHM for Integrated System State and Functional Awareness
- SHM Applications and Test-beds
- SHM Verification and Validation
- SHM as part of a Condition-Based Maintenance Strategy
- SHM and Systems Engineering

## **X. Space Trusted Autonomy**

Space trusted autonomy is a rapidly evolving field, with great potential to transform the way we explore and utilize our solar system. This field lies at the intersection of traditional aerospace engineering, computer and data science, human-autonomy interaction, and satellite subsystem integration/interaction. High assurance automation and autonomy will be increasingly important for safety needs such as collision avoidance, as well as emerging missions such as active debris removal, in-space servicing, assembly and manufacturing (ISAM), and cislunar missions such as those in support of the NASA Gateway and Artemis programs. Papers are sought which tackle autonomy, assurance, or interfaces between humans and autonomy, or any other proposed approaches to support trusted space autonomy. The session(s) aims to provide a forum for the exchange of ideas, best practices, and to foster cross-disciplinary collaboration and innovation in the field.

POCs: Kerianne Hobbs ([kerianne.hobbs@afri.af.mil](mailto:kerianne.hobbs@afri.af.mil)), Sean Phillips ([sean.phillips.9@afri.af.mil](mailto:sean.phillips.9@afri.af.mil)), Alex Soderlund ([alexander.soderlund.1@spaceforce.mil](mailto:alexander.soderlund.1@spaceforce.mil))

Areas of interest include:

- Safe satellite autonomy to include run time assurance approaches such as barrier control functions or model predictive control (MPC) approaches for assuring safety of autonomous space operations
- Robust/resilience guidance navigation control and decision-making systems
- Autonomous cooperative control strategies
- Computationally efficient on-board satellite autonomy algorithms - to include learning, optimization, or adaptive methods
- Human-autonomy interfaces for operators to interact with autonomy on orbit
- Novel techniques to operate in cislunar space including autonomous rendezvous, proximity operations, and docking or resilient constellation design to provide communication and internet to lunar stations
- Autonomous spacecraft behavior estimation
- Autonomous information and data fusion of interconnected heterogeneous space-based sensors
- Ground-based surrogate platforms for space autonomy development - to include software-in-the-loop, processor-in-the-loop, digital-twin and satellite emulation testing environment
- Space autonomy testing metrics and analysis - operational trust metrics and methodologies, autonomous trust acknowledgement between platforms
- Autonomous fault detection and identification methods

## **C. Joint Sessions**

The Intelligent Systems Technical Committee is collaborating with other technical committees to form joint sessions. Proposals for joint sessions are welcome. Please contact each TC's TDC to propose a joint session. Also see <https://www.aiaa.org/scitech> for instructions on proposing special topic sessions.

Sample list of planned and joint sessions that were organized at the past SciTech Forums:

- Cybersecurity in Aerospace Systems [joint w/ SW]
- Interaction of Software Assurance and Risk Assessment Based Operation of UAS [joint w/ US, SW]



- UAS Autonomy and Path Planning [joint w/ US TC]
- Assurance and Benchmarking for Intelligent Unmanned Systems [joint w/ US, SW, GNC]
- V&V Techniques for Increasingly Autonomous Systems [joint w/ SW]
- NASA-DLR Flight Control Research [joint w/ GNC]
- Advances in Adaptive Control Systems [joint w/ GNC]

#### D. Intelligent Systems Best Paper Award 2024

The 2024 Intelligent Systems (IS) Best Paper Award is given to recognize the best overall paper which presents important fundamental contributions to intelligent systems technologies and applications that advance the capabilities of aerospace systems. The best IS paper will be selected from all papers presented during Intelligent Systems sessions at the 2024 SciTech Conference, through an extensive review process and awarded at the 2025 SciTech Conference.

The IS Best Paper Award is chosen based on the following criteria:

- Long-term relevance to IS technologies
- Technically new, innovative, or a constructive review
- Professional integrity (credits prior work, claims are supported by results, and is objective)
- Clear presentation (writing, organization, and graphics)

#### E. Intelligent Systems Student Paper Competition 2024

Graduate students are invited to submit only extended abstracts by the abstract submission deadline in any broad area of Intelligent Systems to the Intelligent Systems Student Paper Competition. Students must be registered as full-time students in good academic standing at the time of submission and must submit full draft manuscripts (must not exceed a total length of 25 pages) by October 27<sup>th</sup>, 2023 to be considered (please note the early manuscript deadline for the competition). Primary or sole authorship by a single student is required, and any second or third author must be the graduate thesis advisor (no more than three authors shall be permitted). A student competition paper subcommittee and the chair will review the full draft manuscripts submitted as IS student paper competition papers based on their originality, clarity, and potential impact on practical applications or theoretical foundations, and select 5 or 6 paper finalists. All papers that are not selected will be forwarded to the area chairs for possible inclusion as regular conference papers. A student paper competition session will be held on Monday, January 8<sup>th</sup>, 2024 during the conference; the finalists will present once at SciTech during this session. Directly after this session, the subcommittee will decide the winner based on both the paper and the presentation, and the student will be notified by email. The winner will be presented with an award at the award luncheon during SciTech 2024.

**Final Manuscript Deadline for Student Paper Competition: October 27<sup>th</sup>, 2023**

POC: Jay Wilhelm (jwilhelm@ohio.edu)

#### F. Invited Discussion Panel Sessions

Please prepare a one page abstract for a trending topic of interest, including a list of panelists and short bios for each. Submit the one page abstract directly to the reviewers listed below by the due date June 1, 2023:

David Casbeer  
Air Force Research Laboratory  
david.casbeer@afrl.af.mil

Yan Wan  
University of Texas at Arlington  
yan.wan@uta.edu

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Air Force Research Laboratory  
isaac.weintraub.1@afrl.af.mil