

AIAA Intelligent Systems Call for Papers AIAA Science and Technology Forum and Exposition (SciTech 2023)

23 – 27 January 2023
Gaylord National Harbor, National Harbor, MD

DRAFT PAPER DEADLINE: 2000hrs/8pm Eastern Time 1 June 2022

SUBMISSIONS: <http://www.aiaa-scitech.org>

ORGANIZING COMMITTEE

IS Technical Discipline Chair

Liang Sun
New Mexico State University
lsun@nmsu.edu

IS Deputy Technical Discipline Chair

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

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/sub-systems 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.

A. Submission Guidelines

Please submit 5-page extended abstracts using the link at <http://www.aiaa-scitech.org>.

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 if accepted.

- **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)** (<http://arc.aiaa.org/loi/jais>).
- **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 (wilhelj1@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 <http://www.aiaa-scitech.org>.



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 on previous work and current state-of-the-art (very important: please ensure correct formatting/spelling of all works cited and include DOI);
- d. State specific innovations and/or technical contributions, including acknowledgment of any previously published works being built upon;
- e. Present sufficient initial evidence in appropriate detail to support correctness of proposed ideas (e.g. preliminary data from simulation/hardware experiments, theorems with proofs/proof sketches, illustrative numerical examples, etc.);
- 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 7 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 <http://www.aiaa-scitech.org> for instructions on proposing special topic sessions. See Section F for instructions on proposing panel discussions.

I. Autonomy

Autonomy can help achieve new levels of efficiency, capability, and resilience through software-based sense-decide-act cycles. Autonomy can be defined as “the quality or state of being self-governing,” which sets it apart from automation. “Autonomous systems” are capable of decision-making without constant human supervision. In aerospace, autonomy could enable new functionalities, improve efficiency, and offer “self-governance” without (regular) human supervision or operation. Aerospace systems with autonomous capabilities include the Mars rover that plans and executes its mission for the next day with only “acceptance” from earth-based operators, rendering it “self-governing”, aircraft flight envelope protection systems that prevent stall upsets for “self-preservation” as a basic form of autonomy, and software-based controlled flight into terrain (CFIT) detect-and-avoid systems that override pilot commands.

Papers are sought in the general area of autonomy and specific topic areas in the categories below:

POC: John Bird (john.bird@colorado.edu) and Anjan Chakrabarty (anjan.chakrabarty@nasa.gov).

Areas of interest include:

- UAS autonomy
- Autonomy and autonomous systems in aerospace
- Runtime assurance
- Verification and validation of autonomy and autonomous systems
- Multi-agent systems and collaborative control
- UAS traffic management (UTM)

II. Cybersecurity in Aerospace Systems [joint with Software]

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 happened, such as hackings of ground-based airline flight planning computer networks and GPS spoofing of military drones. Vulnerabilities to cyber-physical systems allowing remote access in ground-based ATC computer networks as well as aircraft cockpit systems have been found.

POC: Sam Adhikari, sadhikari@sysoft.com

Areas of interest include:

- Computational intelligent methods and tools to detect hacking, jamming and spoofing of aerospace and ground-based systems or other cyber-physical systems
- Methods for monitoring and on-board detection/prevention of deviations from intended operations and other cybersecurity risks or threats for aerospace applications

III. 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: Yan Wan (yan.wan@uta.edu), Danielle Clement (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)

IV. 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, Alexander Stimpson ajstimps@gmail.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 supports
- Pilot and controller mode awareness
- Cockpit decision aids



- Pilot and controller workload
- Air traffic management automation tools
- Dynamic airspace reconfiguration

V. 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)

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

VI. Adaptive and Intelligent Control Systems

Papers are sought that address innovative approaches to intelligent adaptive control system development. Topics of interest include, but are not limited to, adaptive systems, multi-agent systems, parameter estimation, feedback and feed-forward control systems, model reference adaptive control, and adaptive nonlinear systems as applied to aerospace systems.

POC: Kadriye Merve Dogan (dogank@erau.edu) and John Valasek (valasek@tamu.edu)

Areas of interest include:

- Adaptive systems in aerospace
- Adaptive sampling
- Parameter estimation and sensor data fusion
- Analytical and experimental tools for design and validation
- Model reference adaptive control applications
- Nonlinear modeling and control



- Model predictive control applications
- Verification and validation of adaptive systems
- Multivariable control in aerospace systems

VII. 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 operation as well as for fault management, condition-based maintenance (CBM), 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), Bill Maul (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

VIII. 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.

POC: Natasha Neogi (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 systems



IX. 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, 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: Kerianne Hobbs (kerianne.hobbs@afresearchlab.com), Jack Langelaan (jlangeaan@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,
- **Flight Control Certification:** Certification of novel control architectures, hybrid methodologies, safety metrics,
- **Validation and Verification:** Correlation issues in V&V, model-based testing, flight validation of high-integrity manned/unmanned aircraft 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.

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 <http://www.aiaa-scitech.org> for instructions on proposing special topic sessions.

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

- 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 2023

The 2023 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 2023 SciTech Conference, through an extensive review process and awarded at the 2023 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 2023

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 24th, 2022 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 23, 2022 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 2023. In addition, a monetary prize for an amount of \$500 will be mailed to the winner after the conference is concluded.

Final Manuscript Deadline for Student Paper Competition: October 24, 2022

POC: Jay Wilhelm (wilhelj1@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 one of the reviewers listed below by the due date June 1, 2023:

Liang Sun - New Mexico State University(lsun@nmsu.edu)

David Casbeer – Air Force Research Laboratory (david.casbeer@us.af.mil)