AIAA Guidance, Navigation, and Control Conference Call for Papers
AIAA Science and Technology Forum and Exposition (SciTech 2019)

<u>**Draft Paper Deadline:**</u> 11 June 2018

<u>**Submissions:**</u> http://www.aiaa-scitech.org

<u>Organizing Committee</u>

Technical Discipline Chair
Uday J. Shankar
Johns Hopkins Applied Physics Lab
Uday.Shankar@jhuapl.edu

Deputy Technical Chair
John M. Carson III
NASA Johnson Space Center
John.M.Carson@nasa.gov

Deputy Technical Chair
Julie Parish
Sandia National Laboratory
jparish@sandia.gov

<u>Event Synopsis</u>

The AIAA Guidance, Navigation, and Control Technical Committee is inviting participation in the 2019 AIAA Guidance, Navigation, and Control (AIAA GN&C) Conference. This conference is part of the AIAA Science and Technology Forum and Exposition (SciTech 2019), an event that provides the world's premier forum for presentation, discussion, and collaboration on science, research, and technology related to the aerospace industry. The AIAA GN&C Conference is the largest forum dedicated to guidance, navigation and control (GN&C) serving the aerospace community, and it brings together experts from industry, government, and academia on an international level to present and discuss numerous technical areas related to aerospace applications.

The GN&C Conference consists of a set of invited sessions, technical sessions, and a graduate student paper competition. A set of papers on a given topic may be proposed as an Invited Session. Individual papers may be submitted to the technical areas listed below. ***Submission requirements are detailed below. Please read and follow the submission requirements carefully.*** Eligibility criteria and submission requirements for the Graduate Student Paper Competition, also sponsored by the GN&C Technical Committee, are detailed here.

Invited Sessions

(Proposal Deadline: 23 April 2018)

Invited session proposals are solicited in any of the topic areas listed below as well as in new or emerging technical areas. Papers in an invited session should form a cohesive focus on the relevant topic. Inclusion of a reasonable diversity of viewpoints is encouraged.

Procedure: *The procedure for submitting an invited session proposal is different from the normal paper submission procedure.* The invited session organizer should submit the entire session as a whole to BOTH the technical chair and co-chair below by 20 April 2018. Invited session organizers should invite authors to participate, collect the required information, assemble the Session Proposal Packet, and submit the Session Proposal Packet as one file to the technical chair and co-chair listed below.

Session Proposal Packet: The Session Proposal Packet should be submitted as a single document and include a Session Title and a one- or two-page Summary Statement that describes the motivation and relevance of the proposed session. The document should have the session organizer contact information, along with details on each paper, including title, authors, author affiliation, and a few sentences describing the paper. The technical chair and co-chair will notify each organizer of the acceptance or rejection of their session by **18 May 2018**.

Individual Paper Submission: Following the acceptance of an invited session, the individual extended abstracts for a session must be electronically submitted to the "Invited Session" area by the individual contributing authors. Extended abstracts should be at least 1000 words (not including references) and must include sufficient detail to demonstrate the purpose of the paper, the technical foundation for the topics to be discussed, any preliminary results to date, and the expected results of the final paper, including key figures, equations, tables, and references, as appropriate. Sufficient information must be included in the submission to convince the technical chair and co-chair and reviewers that the author(s) will have a strong likelihood of completing the final manuscript by the final manuscript submission deadline. The individual extended abstracts must be submitted by the conference abstract deadline of 11 June 2018, and final manuscripts are due 4 December 2018. Authors of individual papers must send their paper tracking number to the organizer of their invited session. The invited session organizer, in turn, must forward to the GN&C Invited Session Chair and Co-Chair, the complete list of paper tracking numbers for their invited sessions.

Evaluation of Individual Papers: Please note that at the discretion of the Technical Program Committee, individual papers may be rejected and/or removed from proposed sessions and replaced by an appropriate contributed paper. Likewise, selected papers from rejected Invited Sessions may be placed into the regular program.

Invited Session Chair	Invited Session Co-Chair	Invited Session Co-Chair
Jonathan Muse	Jason Gross	Heidi Hallowell
Air Force Research Laboratory	West Virginia University	Ball Aerospace
jonathan.muse.2@us.af.mil	jason.gross@mail.wvu.edu	hhallowe@ball.com

Draft Manuscript Submission Guidelines for GN&C Technical Areas

Paper selection for non-invited sessions will be based on a **full draft manuscript** of the proposed technical paper. *No exceptions, please!* **Draft manuscripts and final papers must not exceed a total length of 25 pages.** Each draft must begin with a 100- to 200-word abstract, and an introduction that includes a brief assessment of prior work by others and an explanation of the paper's main contributions. The manuscript must include sufficient detail to allow an informed evaluation of the paper.

Technical Topics

Papers covering all aspects of guidance, navigation, and control of aerospace systems may be submitted. Specifically, papers should describe novel analytical techniques, applications, and technological developments in areas such as: the guidance, navigation, and control of aircraft, spacecraft, launch vehicles, missiles, aerospace robotics, unmanned/autonomous systems, and other aerospace systems; general aviation; in-flight system architecture and components; navigation and position location; sensors and data fusion; and multidisciplinary control. Please refer to the following individual technical area descriptions to determine the topic that most closely aligns with your paper. If your paper aligns with multiple topics, please choose whichever topic seems to most closely align. If you have further questions, please contact the technical discipline chairs, the individual area chairs, or co-chairs. Papers are invited for the following topics. Detailed descriptions of these topics follow (or, click on the topic).

- [Control and Autonomy: Theory, Analysis, and Design](#)

- [Navigation, Estimation, and Tracking: Theory and Sensors](#)

- [Distributed and Cooperative Systems: Estimation and Control](#)

- [Intelligent/Autonomous Aerial Systems](#)

- [Space Robotic Systems](#)

- [Aircraft Guidance, Navigation, and Control](#)

- [Spacecraft Guidance, Navigation, and Control](#)

- [Missile Guidance, Navigation, and Control](#)

Please note that, at the discretion of the Technical Program Committee, papers may be moved between topic areas if the paper is better aligned with another topic.

Control and Autonomy: Theory, Analysis, and Design

Papers are sought that develop new theories, generate new algorithms, derive new analysis, techniques or design tools, or modify and improve existing techniques for general application to control of aerospace vehicles. Topics of interest include robust control, nonlinear control, optimal control, multivariable control, adaptive and intelligent control, fault detection, redundancy management and bio-inspired control. Papers describing new analysis and synthesis techniques with illustrative realistic aerospace control examples are strongly encouraged. Papers discussing applications of existing control theoretic methods should be submitted to other technical areas that most closely matches the application. Examples of specific topics within the broad subject areas include:

- **Robust Control**: techniques for control design of systems with uncertainty; feedback stability, mu analysis and gain scheduling; multivariable stability margins and multiplier theory; mu-synthesis and H-infinity-optimal control.

- **Nonlinear Control**: techniques and methods for control of nonlinear models; Lyapunov techniques and their extensions; linear matrix inequalities; applications of nonlinear control methods, such as sliding mode or feedback linearization techniques.

- **Optimal Control**: optimization algorithms; objectives and issues in optimal control of nonlinear systems; dynamic programming; solution methods; case studies in analysis and design of optimal controllers for MIMO plants; robustness and stability margins; design tradeoffs.

- **Adaptive Control**: Model Reference Adaptive Control and variants, Lyapunov stability analysis of adaptive control laws; direct and indirect adaptive control for linear and nonlinear systems; computational challenges; adaptation rules; verification of margins for flight critical systems; models and learning rules in artificial neural networks; neural networks in system identification and control.

- **Fault Detection and Reconfiguration**: algorithms to detect sensor and effector faults; switchover control laws; simulations with fault injection and recovery performance.

- **Control Allocation**: control allocation laws including management of multiple effectors; verification and validation of redundancy management methods; implementation in real- time software.

- **Verification and Validation**: formal safety assurance techniques including model checking and theorem proving for studying complex aerospace systems; abstraction schemes; computational challenges; run-time assurance; implementation in real-time.

- **Other**: original theoretical contributions motivated from aerospace applications will also be considered.

Technical Area Chair	**Technical Area Co-Chair**	**Technical Area Co-Chair**
Mrinal Kumar	Jeffrey Kornuta	Lorenzo Pollini
Ohio State University	Exponent, Inc.	Università di Pisa
Email: kumar.672@osu.edu	jkornuta@exponent.com	lpollini@dsea.unipi.it

Navigation, Estimation, and Tracking: Theory and Sensors

Papers are sought that develop new theory, approaches, and applications associated with navigation, estimation, and tracking. Broad subject areas include estimation and navigation techniques and tracking methods. Examples of specific topics within the broad subject areas include:

- **Estimation**: parameter estimation; robust and adaptive filtering; nonlinear filtering and smoothing; nonlinear observers; distributed estimation; hybrid estimation; integrated estimation/control.

- **Navigation**: biologically-inspired navigation; vision-based navigation; X-ray source- based navigation; terrain-guided navigation; radio navigation; autonomous navigation and control (including integrated GPS and inertial navigation); simultaneous localization and mapping.

- **Tracking**: nonlinear and multi-hypothesis tracking; data association; combined detection/tracking; sensor management; situational awareness; geolocation.

Papers that emphasize missions and systems should be submitted to the Aircraft, Spacecraft and Launch, Missile, or Mini/Micro Air Vehicle GN&C technical areas.

Technical Area Chair
Manoranjan Majji
University of Buffalo
mmajji@buffalo.edu

Technical Area Co-Chair
Haiyang Chao
University of Kansas
chaohaiyang@gmail.com

Distributed and Cooperative Systems: Estimation and Control

Papers are sought that deal with the theory and application of all aspects of distributed and cooperative control of multi-vehicle and/or human-in-the-loop systems within aerospace GN&C. Papers are sought that present innovative developments; implementation and certification issues; planner, controller and estimator design; and distributed/cooperative decision-making and control of autonomous agents, and mixed initiative control of semi-autonomous teams for a variety of aerospace applications.

- **Planner, Controller, and Estimator Design**: multi-vehicle or distributed planners, controllers and estimators designed using rule-based and model-based techniques, machine learning, neural networks, fuzzy logic, reinforcement learning, evolutionary algorithms, and bio-inspired control techniques.

- **Cooperative Decision and Control of Autonomous Agents**: cooperative task assignment and trajectory optimization; biologically-inspired group behavior and control schemes.

- Mixed Initiative Control of Semi-Autonomous Teams: team auto-routing and coordinated rendezvous.

- **Cooperative Control with Uncertainty**: accommodation of effects of atmospheric and relative orbital drift effects on formations; noisy navigation or unreliable propulsion systems.

- **Applications**: distributed and cooperative control and estimation applications for aircraft, missiles, spacecraft, smart autonomous vehicles, mission-planning management, multi- objective control, system integration, fault detection, identification, and accommodation issues. Platforms include Unmanned Aerial Vehicles (UAVs), Unmanned Combat Air Systems (UCAS), Unmanned Ground Vehicles (UGVs), Unmanned Underwater Vehicles (UUVs), Wide Area Search Munitions (WASMs), and satellite constellations and/or clusters.

Particular interests are in the stability and robustness of complex distributed control tasks, as well as in real-time implementations.

Technical Area Chair
Michael Oppenheimer
U. S. Air Force
michael.oppenheimer@us.af.mil

Technical Area Co-Chair
William Whitacre
Draper Laboratory
wwhitacre@draper.com

Intelligent/Autonomous Aerial Systems: UAVs, Mini-Micro and Multi-Rotor Vehicles; Path Planning

Papers are sought that address the challenges and missions associated with UAVs, mini and micro, and multi-rotor air vehicles. Fixed wing, rotary wing and flapping wing developments are all of interest. Main topic areas include:

- **New Designs/Capabilities**: new vehicle designs, and the interaction between the vehicle design and control synthesis process; sensor processing and control algorithms that enable autonomous perching and in-flight docking; atmospheric energy harvesting.

- **Sensors and Data Fusion**: state estimation algorithms suitable for implementation on MAVs; navigation in GPS denied environments; vision-based MAV autonomy. Innovative and new sensors for mini/micro air vehicles.

- **Power Systems and Actuators**: high-voltage, low-current power conversion for piezoelectric actuators for MAVs; battery or fuel cell improvements.

- **Flight Dynamics and Control**: dynamic modeling of fixed, rotary and flapping wing MAVs; effects of realistic atmospheric conditions on modeling and flight control; flight control architectures for MAVs; bird and insect inspired flight.

- **Trajectory Planning**: planning algorithms suitable for implementation on MAVs; operation in constrained environments, near obstacles; effects of realistic atmospheric conditions on flight trajectories.

- **Experiments**: new empirical unsteady aerodynamic models; low Reynolds number aerodynamic force and moment characterization; identification of actuator and vehicle flight characteristics; fluid-structure interaction characterization and implications for control design.

Please note that papers dealing with multiple unmanned vehicles (large or mini/micro) should be directed to the Distributed and Cooperative Control in Aerospace Applications technical area.

Technical Area Chair
Eric Johnson
Penn State University
Eric.Johnson@engr.psu.edu

Technical Area Co-Chair
Amanda Lampton
Systems Technology, Inc.
alampton@systemstech.com

Space Robotic Systems: Autonomous Satellite Servicing, Space Debris Removal, Planetary Rovers

Papers are sought that deal with the GN&C design and challenges related to robotics and unmanned/autonomous systems, as well as research related to handling and operations. In particular, papers that relate ground-based vehicles, UAVs, planetary rovers, and robotics for spacecraft servicing missions are welcome. Broad subject areas include: sensor/data fusion for navigation and perception; trajectory planning and tracking; and dynamical modeling and control of robotic vehicles and manipulators.

- **Sensor/Data Fusion**: sensor-based navigation, including simultaneous localization and mapping (SLAM) concepts; vision-based navigation systems using optical flow, occupancy grids, potential fields, and global and inertial navigation systems; autonomous navigation in GPS-denied environments; novel inertial guidance and control sensors; mobile ad-hoc networks for swarming unmanned vehicles; networked sensors for vehicle control and navigation.

- **Trajectory Planning and Tracking**: methods of trajectory planning and tracking for vehicles in uncertain environments, including optimal trajectory planning and probabilistic methods.

- **Dynamical Modeling and Control**: equations of motion for unique robotic or unmanned/autonomous vehicles or robotic manipulators, including the treatment of motion or dynamic constraints, and control challenges related to the dynamics of the vehicles or robotic manipulators.

Papers specifically related to the design and control of MAVs may be better suited in the Mini/Micro Air Vehicle GN&C technical area unless they have a strong robotics aspect; and papers specifically related to distributed and cooperative control of multi-vehicle systems may be better suited in the Distributed and Cooperative Control in Aerospace Applications technical area unless they have a strong robotics aspect.

Technical Area Chair
Steve Ulrich
Carleton University
Steve.Ulrich@carleton.ca

Technical Area Co-Chair
Daniel Choukroun
Ben Gurion University of the Negev
danielch@bgu.ac.il

Aircraft Guidance, Navigation, and Control

Papers are sought that address the development, simulation, and flight testing of GN&C systems for aircraft and helicopters. Papers on GN&C concepts in Air Traffic Management are also encouraged to submit. Papers that emphasize novel theoretical designs, including high-fidelity and detailed simulation/simulator results, and/or experimental results will be considered preferably. Areas of interest include:

- **Augmented Flight Control Systems**: stability and control augmentation; automatic flight path and speed control; auto pilot control; integrated guidance and control; trajectory generation and energy management; interdisciplinary flight control and vehicle performance; nonlinearities; structural control and vibration suppression; aeroservoelasticity; limitations of control effectors (e.g., saturation).

- **Fault Tolerance and Recovery Systems**: self-repairing or reconfigurable systems; situational awareness; command and decision support; flight envelope protection; trajectory recomputation and reconfiguration; fault detection and isolation.

- **Navigation and Flight Management Systems**: navigation algorithms; GNSS positioning; alternative navigation sensors; autonomous navigation; GPS performance and status; trajectory design; flight director design.

- **Flight Control Analysis and Flight Test Evaluation**: aircraft handling qualities; human- machine interface; pilot-in-the-loop; integrated vehicle ground testing; taxi testing; robustness and performance analysis on flight controlled systems.

- **Formation Flight Control with Uncertainties**: aircraft formation flight for drag savings; swarming, platooning, mobile sensor air networks; accommodation of atmospheric uncertainties on formation control.

- **Aircraft GN&C Sensors**: sensor testing and performance evaluation results from actual hardware; new GN&C sensor concepts; new techniques for designing, modeling, simulating, and prototyping sensors; sensor factory or in-situ calibration techniques; fielding of sensor systems that support GN&C; miniaturization of hardware and applications; redundancy management of multiple sensors used by the onboard avionics systems.

- **GN&C Concepts in Air Traffic Management**: development and testing of new air traffic control (ATC) decision support tools; future ATC concepts for separation assurance; development and testing of new flight-deck avionics and communication, navigation, and surveillance capabilities; integration of future concepts; new uses of weather information and integration in the cockpit; enhanced planning and scheduling concepts.

Technical Area Chair
Animesh Chakravarthy
Wichita State University
animesh.chakravarthy@wichita.edu

Technical Area Co-Chair
Tansel Yucelen
University of South Florida
yucelen@usf.edu

Spacecraft and Launch Guidance, Navigation, and Control

Papers are sought that deal with topics specific to GN&C of launch, on-orbit flight and/or recovery of single or multiple space vehicles. Broad areas cover the design and challenges for on-orbit operations, as well as mission studies for human exploration, unmanned missions, GN&C algorithms for ascent and entry, GN&C architecture and rapid prototyping, novel sensors, actuators and grappling mechanisms, multidisciplinary design and optimization. Areas of interest include:

- Ascent, Entry, Descent, and Landing GN&C: ascent, rendezvous, on-orbit operations, entry, and landing as well as sensing systems for ascent, landing, rendezvous or deep space operations.

- Reusable Vehicles: Commercial Crew Integrated Capability (CCiCap), next-generation systems involving hypersonic entry vehicles (RLVs), or systems with reusable stages.

- Attitude and Orbit Dynamics, Determination, and Control: applications of attitude estimation and control; orbit estimation and control; momentum control, payload pointing and articulation; and GN&C and attitude determination and control software implementation for spaceflight use. Theoretical discussions should be supported by simulation, test, and/or flight performance data where possible.

- Innovative Techniques to Improve Performance: novel GN&C approaches or techniques for space systems, applications involving existing sensors and actuators; new mission planning approaches that will reduce development cost; reduction of structural dynamic interaction or coupling between vehicle systems, GN&C actuation and disturbances; tolerance to failures in sensors, actuators, and structural integrity; tools and methods that support rapid trade space analysis for new vehicle concepts. Discussions on system-level error sources affecting GN&C functions are also encouraged.

- GN&C Systems for Space Missions: Earth and space science missions; unclassified topics concerning defense and surveillance satellites; International Space Station and its resupply and servicing vehicles; low-Earth-orbiting and geostationary communications satellites; small satellites (including CubeSats); and GN&C consideration of future space systems; recent in-orbit experiences of GN&C and attitude determination and control systems.

- Spacecraft Formation Control: formations; constellations; approach, rendezvous and docking; proximity operations; distributed aperture satellite formations.

- Human Exploration Missions: GN&C and targeting for Human Spaceflight Exploration (MPCV, etc.); new capabilities required for manned asteroid, lunar, and Mars missions; ascent or entry flight phases on Earth (for the MPCV, SLS), the moon, asteroids, and other planets (for exploration missions).

- Unmanned Missions: Commercial Orbital Transportation Services (COTS)/Commercial Resupply Services (CRS), or general improved autonomy, capability, and reliability.

- Spacecraft and Launch Vehicle Sensors: sensor testing and performance evaluation results from actual hardware; new GN&C sensor concepts; new techniques for designing, modeling, simulating, and prototyping sensors; sensor factory or in-situ calibration techniques; fielding of sensor systems that

support GN&C; miniaturization of hardware and applications; redundancy management of multiple sensors used by the onboard avionics systems; voting, selection, and tests; verification and validation of redundancy management schemes; implementation in real-time software; sensors for autonomous landing.

For papers that primarily focus on the robotics component of the GN&C problem, authors should submit to the Aerospace Robotics and Unmanned/Autonomous Systems technical area.

Technical Area Chair	**Technical Area Co-Chair**	**Technical Area Co-Chair**
Kevin Bollino	Jason Gross	Heidi Hallowell
U.S. Air Force	West Virginia University	Ball Aerospace
Bollinok2@gmail.com	jason.gross@mail.wvu.edu	hhallowe@ball.com

Missile Guidance, Navigation, and Control

Papers are sought that relate to GN&C of missiles, launch vehicles, and reentry vehicles. Topics include design, analysis, simulation, and test of complete systems or subsystems. Examples of specific topics within the broad subject areas are:

- **Modern Autopilot/Guidance Approaches:** applications of modern robust and adaptive control algorithms to missile control, guidance, and integrated guidance and control.

- **Estimation and Filtering Algorithms:** novel approaches to estimation in missile applications, particularly for achieving high performance with lower fidelity sensors or multiple dissimilar sensors.

- **Trajectory Optimization:** design and analysis of control laws to achieve optimum trajectories for intercept guidance and reentry applications.

- **Computer-Based Design and Analysis Techniques:** advances in numerical guidance and control design and analysis methods including adjoint simulations.

- **Missile Applications:** GN&C designs for specific applications such as ship defense and national or theater missile defense systems.

- **Missile Sensors:** sensor testing and performance evaluation results from actual hardware; new GN&C sensor concepts; new techniques for designing, modeling, simulating, and prototyping sensors; sensor factory or in-situ calibration techniques; fielding of sensor systems that support GN&C; miniaturization of hardware and applications; redundancy management of multiple sensors used by the onboard avionics systems; voting, selection, and tests; verification and validation of redundancy management schemes; implementation in real-time software.

Technical Area Chair
Brian Biswell
Raytheon Company
Brian.L.Biswell@raytheon.com

Technical Area Co-Chair
Michael McFarland
Orbital ATK
michael.mcfarland@orbitalatk.com

GN&C Graduate Student Paper Competition

The GN&C Technical Committee will host a Graduate Student Paper Competition at SciTech 2019. In addition to appropriate recognition, all finalists in the GN&C Graduate Student Paper Competition will receive a monetary award of $500 and complementary registration. The overall winner will receive an additional $1,000 award.

For this competition, full draft manuscript papers are sought from graduate students on GN&C technical research topics, from which up to six finalists will be selected by a panel of judges for inclusion in a special GN&C Graduate Student Paper Competition session. Author eligibility and manuscript submission requirements are described below.

Eligibility Requirements

- A student must be the primary or sole author, enrolled at an institution of higher learning.

- The student will be expected to sign a form, if selected as a finalist, stating that they contributed the overwhelming majority to the paper's written and technical content.

- The student author must be a member of AIAA in order to become a finalist in the competition.

- The student author must be a full-time graduate student in good academic standing at his or her university/institution at the time of submission.

- Full draft manuscript not exceeding a total length of 25 pages.

- The student author is not the overall winner of the preceding year's competition.

- Only one paper submission per primary author.

Submission Requirements

- Graduate Student Paper Competition submissions must adhere to the overall Forum Abstract Submission Requirements.

- Students must select the "Student Paper Competition" presentation type during the electronic submission process. Do not submit the abstract more than once. Only submissions with "Student Paper Competition" presentation type indicated will be eligible for the competition.

- All submissions must be made by the Forum abstract submission deadline.

Finalists will be required to make two presentations at the Forum: once in the appropriate regular technical session and once in a separate Graduate Student Paper Competition session. Note that authors will receive an accept/reject notification first for the regular conference review process and later for the graduate student paper competition. The second notification will be from the GN&C Technical Committee. A paper can be (1) accepted for both the regular conference and competition, (2) accepted to the regular conference, but not the

competition, or (3) not accepted to either the regular conference or the competition.

Graduate Student Paper Chair
Joseph Connolly
NASA Glenn Research Center
Joseph.W.Connolly@nasa.gov

Graduate Student Paper Co-Chair
Julie Parish
Sandia National Laboratory
jparish@sandia.gov