AIAA Guidance, Navigation, and Control Conference Call for Papers

AIAA Science and Technology Forum and Exposition (SciTech 2015)

DRAFT PAPER DEADLINE: 2 June 2014
SUBMISSIONS: http://www.aiaa-scitech.org

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EVENT SYNOPSIS
The AIAA Guidance, Navigation, and Control Technical Committee is inviting participation in the 2015 AIAA Guidance, Navigation, and Control Conference. This conference is part of the AIAA Science and Technology Forum and Exposition (SciTech2015), an event that will provide the world’s premier forum for presentation, discussion, and collaboration of science, research, and technology related to the aerospace industry. The AIAA Guidance, Navigation, and Control Conference is the largest forum dedicated to guidance, navigation and control (GN&C) serving the aerospace community. It brings together experts from industry, government, and academia on an international level to present and discuss all technical areas related to GN&C for aerospace applications.

DRAFT MANUSCRIPT SUBMISSION GUIDELINES FOR GN&C CONFERENCE
Paper selection for this conference will be based on a full draft manuscript of the proposed technical paper. No exceptions will be made. 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 body of 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, missiles, robotics, and other aerospace systems; general aviation; in-flight system architecture and components; navigation and position location; sensors and data fusion; multidisciplinary control; and GN&C concepts in air traffic control systems and high-speed flight. Please refer to the following individual technical area descriptions to determine the topic that most closely aligns with your paper. Please contact the GN&C Technical Area Chairs or Co-Chairs with questions.
Control 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 flight 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 control theory should be submitted to the area 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 and Intelligent 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**: algorithms to detect sensor and effector faults; switchover control laws; simulations with fault injection and recovery performance.
- **Redundancy Management**: redundancy management of multiple sensors and effectors used by the control laws; voting, selection, and tests; verification and validation of redundancy management schemes; implementation in real-time software.
- **Bio-Inspired Control Methods**: control and optimization algorithms inspired by natural existing phenomena; genetic algorithms, evolutionary algorithms, and swarming algorithms.

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Novel Navigation, Estimation, and Tracking Methods
Papers are sought that develop new theory, approaches, and applications associated with navigation, estimation, and tracking. Broad subject areas include navigation techniques; path planning; tracking methods; and estimation. Examples of specific topics within the broad subject areas include:
- **Navigation Techniques**: 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.
- **Path Planning**: path optimization; trajectory prediction; formation flying.
- **Tracking Methods**: nonlinear and multi-hypothesis tracking; data association; combined detection/tracking; sensor management; situational awareness; geolocation.
- **Estimation**: parameter estimation; robust and adaptive filtering; nonlinear filtering and smoothing; nonlinear observers; distributed estimation; hybrid estimation; integrated estimation/control.
- Papers that emphasize missions and systems should be submitted to the Aircraft, Spacecraft, Missile, or Mini/Micro Air Vehicle GN&C topic areas.

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**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 that emphasize novel theoretical design or include experimental results will be considered preferably. Areas of interest within the broad subject of aircraft guidance, navigation and flight control applications include:

- **Augmented Flight Control Systems**: stability augmentation; automatic flight path and speed control; auto pilot control; integrated guidance & control; trajectory generation and energy management; interdisciplinary flight control and vehicle performance; nonlinearities; structural control and vibration suppression; aeroservoelasticity; saturation of control effectors.
- **Fault Tolerance and Recovery Systems**: self-repairing or reconfigurable systems; situation awareness; 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.

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**Spacecraft Guidance, Navigation, and Control**
Papers are sought that deal with topics specific to GN&C of on-orbit flight of single space vehicles. Areas of interest include:
- **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 approach/techniques for space systems, applications involving existing sensors and actuators; reduction of structural dynamic interaction resulting from instrument articulated mass motion, GN&C actuation, and thermally induced disturbances; tolerance to failures in sensors, actuators, and structural integrity. 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; and GN&C consideration of future space systems. Papers presenting recent in-orbit experiences of GN&C and attitude determination and control systems are also solicited.

For papers that concern multiple vehicles, such as formations, constellations, and rendezvous and docking, authors should submit to the Multi-Vehicle Control topic area. For papers that concern ascent and entry, authors should submit to the Space Exploration and Transportation GN&C topic area. For papers that primarily focus on the sensor component of the GN&C problem, authors should submit to the Sensor Systems topic area.

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**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.
Multi-Vehicle Control

Papers are sought that address the challenges and missions associated with multi-vehicle control. Broad subject areas include cooperative decision and control of autonomous agents, formation flight of air/space vehicles, and mixed initiative control of semi-autonomous teams. Platforms include 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. Examples of specific topics within the broad subject areas are:

- **Cooperative Decision and Control of Autonomous Agents**: cooperative task assignment and trajectory optimization; biologically-inspired group behavior and control schemes.
- **Formation Flight of Air/Space Vehicles**: aircraft formation flight for drag savings; distributed aperture satellite formations; swarming, platooning, mobile sensor networks.
- **Mixed Initiative Control of Semi-Autonomous Teams**: team auto-routing and coordinated rendezvous.
- **Cooperative Control with Uncertainty**: effects of realistic atmospheric conditions on flight control; noisy navigation or unreliable propulsion systems.

Space Exploration and Transportation Guidance, Navigation, and Control

Papers are sought that address GN&C design and challenges for space exploration and space transportation systems. Broad areas include mission studies for human exploration, unmanned missions, GN&C algorithms for ascent, entry and on-orbit phases of flight, GN&C architecture and rapid prototyping, novel sensors, novel actuators and grappling mechanisms, multidisciplinary design and optimization. Examples of specific subjects within these broad areas include:

- **Human Exploration Missions**: NASA 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**: COTS/CRS, or general improved autonomy, capability, and reliability.
- **Reusable Vehicles**: CCI Cap, next-generation systems involving hypersonic entry vehicles, reusable launch vehicles (RLVs), or systems with reusable stages.
- **GN&C Algorithms**: entry, ascent, rendezvous, on-orbit, and landing.
- **GN&C Architecture and Rapid Prototyping**: new guidance, control, or mission planning approaches that will reduce development costs, reduce turnaround time for planning and redesign, or present synthesis tools that support rapid trade-space analysis for new vehicle concepts.
• **Novel Sensors**: sensing systems for rendezvous, ascent, landing, and deep-space operations.
• **Multidisciplinary Design and Optimization**: novel optimal trajectory design and/or online trajectory reshaping methodologies; coupling between the propulsion system, aerodynamics, thermodynamics, control system, and vehicle structure.

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Papers are sought that describe innovative methods for implementing GN&C concepts in air traffic control (ATC) systems, and for modeling, simulation, and analysis of such systems. Near term implementation issues such as the development and testing of new ATC decision support tools, and advanced ATC concepts for automated separation assurance, weather integration, planning and scheduling, and reducing environmental impact of aviation are of interest. Papers that describe operational issues for existing ATC systems, lessons learned from past experience, or field test/evaluation activities are also encouraged. Example areas of application are:

• **Development and Testing of New ATC Decision Support Tools**: decision support tools for integration of new vehicles (e.g., unmanned aerial systems); surface traffic management; conflict detection and resolution; traffic flow management at regional and national levels; airspace configuration for capacity management; integration of capacity management, traffic flow management, and separation assurance; human-in-the-loop evaluation of decision support concepts and tools.

• **Advanced ATC Concepts for Automated Separation Assurance**: concepts and algorithms for ground-based and airborne separation assurance; integrated air-ground separation assurance; guidance using cockpit display of traffic information; benefit assessment of data-link communication, GPS-based navigation, surveillance, and four-dimensional trajectories; methods for conflict detection and resolution on the airport surface.

• **Weather Integration**: analysis of forecasted weather accuracy; improved prediction of weather; translation of weather information into air traffic impact; algorithms for routing around weather; accounting for weather prediction uncertainty in flow management decision making, separation assurance, and scheduling.

• **Planning and Scheduling**: trajectory-based taxi planning and runway scheduling algorithms; gate departure time prediction; methods for improved forecasting of airspace demand and capacity; aggregate flow models; traffic flow management algorithms; techniques for including airline preferences in traffic management decisions; integrated en route and terminal area traffic management.

• **Reducing Environmental Impact of Aviation**: assessment of the environmental impact of aviation; predicting impact based on environmental conditions; relating contrail avoidance and extra fuel consumption; models and algorithms for estimating and reducing fuel consumption and exhaust gases.
Sensor Systems for Guidance, Navigation, and Control

Papers are sought that describe novel stand-alone sensors, integrated sensor systems, and innovative sensing techniques for GN&C of surface, maritime, air, or space vehicles. Papers may address sensor systems for crewed or uncrewed vehicles. Papers describing innovative research, development, design, and integration work with illustrative GN&C sensor systems applications are highly encouraged. Examples of specific subjects within these broad areas include:

- **Sensor Design, Testing, and Performance Improvement**: 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; and fielding of sensor systems that support GN&C.
- **Miniaturization of Sensor Systems**: miniaturization of hardware and applications of relevant micro and nano-technologies; integrated sensor suites (e.g. sensor-on-chip, etc.).
- **Application Areas**: 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; computer vision for autonomous navigation, obstacle avoidance, collision avoidance and autonomous landing; and GN&C sensors in pointing, alignment, and robotic manufacturing applications.

Papers submitted to this area should primarily focus on the sensor component of the GN&C problem. Due to the broad application of sensor systems in GN&C, some papers may be better suited for presentation in application-specific technical areas such as Aircraft GN&C, Spacecraft GN&C, Multi-Vehicle Control, and Mini/Micro Air Vehicle GN&C. Please refer to individual technical area descriptions for further details and feel free to contact the GN&C Technical Area Chairs with questions on which area would be best for specific topics.

Mini/Micro Air Vehicle Guidance, Navigation, and Control

Papers are sought that address the challenges and missions associated with mini and micro air vehicles (MAVs—vehicles that are small enough to be human-portable). 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 vehicles; navigation in GPS denied environments; vision-based MAV autonomy.
• **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 mini/micro air vehicles; 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 large UAVs or human/UAV interaction should be directed to the Human and Autonomous/Unmanned Vehicle Systems technical area, and papers dealing with multiple unmanned vehicles (large or mini/micro) should be directed to the Multi-Vehicle Control technical area.

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**Human and Autonomous/Unmanned Systems**

Papers are sought that describe the principles and methodologies for effective collaboration and interactions of humans and autonomous/unmanned systems (e.g., remotely piloted platforms from terrestrial/sea/air/space domains). Proposed advances should include theoretical foundations and autonomy technologies for design, implementation, verification and validation with confidence and trust of unified human and autonomous/unmanned systems that are capable of distributed intelligent sensing, onboard planning and execution, and collaborative distributed decision making. Papers that address the R&D challenges pertaining to future flexible autonomous/unmanned systems in support of human-centered or human-augmented missions, in simulation, laboratory implementations, field testing, or flight-testing will be considered preferentially. Modeling, evaluating, or quantifying the human behaviors in human-machine interactions will be of special interests. Examples of specific topics within the broad areas include:

• **Distributed Intelligent Sensing**: integrated sensor architectures; multi-sensor and information fusion approaches for responsive scene representations and timely understanding of multi-hypothesis and multi-evidence phenomenologies pertaining to contested and congested environments and subject to sensor types and operational modes, sensor kinematics, platform constraints, collection robustness, observation efficiency, etc.

• **Onboard Planning and Execution**: open and distributed architectures of highly heterogeneous systems including tactical autonomous/unmanned systems and/or theater-level human centered systems; hierarchical decompositions of tasks and behaviors among autonomous/unmanned systems with considerations of generality vs. depth, coverage vs. redundancy; validation and verification techniques via model-based analysis and agent-based conceptual modeling; and hardware-in-the-loop simulations and emulations.
• **Collaborative Distributed Decision Making**: multi-level concepts and integrated frameworks with cross-domain interactions; human-augmented decision making; robust and secure communications; and advanced decision support tools for assessment of mixed initiative control and coordination subject to performance metrics of operational effectiveness, efficiency, recoverability, etc.

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**Intelligent Control in Aerospace Applications**
Papers are sought that deal with the theory and application of all aspects of intelligent control within aerospace GN&C. Papers are sought that present innovative developments; implementation and certification issues; planner, controller and estimator design; and intelligent control and estimation for a variety of aerospace applications.

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

• **Applications**: intelligent 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.

Particular interests are in the stability and robustness of complex distributed control tasks, as well as in real-time implementation. Papers focusing on adaptive control theory should be submitted to the Control Theory, Analysis, and Design technical area.

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**Aerospace Robotics and Unmanned/Autonomous Systems**
This area includes 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 to autonomous systems, such as: cooperative 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.

• **Trajectory Planning and Tracking**: methods of trajectory planning and tracking for single or multiple 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 Mini/Micro Aerial Vehicles (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 Multi-Vehicle Control technical area unless they have a strong robotics aspect.

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**Invited Sessions (PROPOSAL DEADLINE IS 17 APRIL 2014)**

Invited session proposals are solicited in any of the topic areas listed above 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 will submit the entire session as a whole to BOTH the technical chair and co-chair below by **17 April 2014**. 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 one to two page Session Title and Summary Statement that describes the motivation and relevance of the proposed session. The document should have the session organizer contact information and information 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 **10 May 2014**.

**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. The individual extended abstracts must be submitted by the conference abstract deadline of **2 June 2014**, and final manuscripts are due **1 December 2014**. Authors of individual papers should send their paper tracking number to the organizer of their session.

**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.

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