Research Title: Design and Verification of Automatic, Autonomous, and Intelligent Aerospace Control Systems

Individual Sponsor:

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Academic Area/Field and Education Level: Aerospace Engineering, Mechanical Engineering, Electrical Engineering, Computer Science, Mathematics, or Robotics with emphasis in the fields of autonomous vehicle guidance, navigation and control, machine learning, run time assurance, or formal methods.

Objectives: Research and develop planning, guidance, and control methodologies and accompanying verification approaches for aerospace systems such as fixed wing aircraft, rotary wing aircraft, or spacecraft operating collaboratively. Verification approaches can include offline verification such as formal methods and mathematical analysis or novel test case generation techniques, as well as online verification approaches such as run time assurance.

Description: Autonomous systems that utilize novel control techniques, including those based on machine learning, promise to improve the speed with which systems can react in real time to changing mission needs and reduce the number of humans required to operate large numbers of unmanned aircraft or a constellation of satellites. However, hard to detect design flaws in advanced controllers could have catastrophic consequences, especially in safety critical applications. The controller designs should address issues such as simultaneous satisfaction of multiple design constraints, real time task assignment and prioritization, effects of uncertainty with information and game theory considerations, operation on processing and memory constrained computing hardware, interactions with human operators, and scalability of the design. Verification of these controller designs should include provably correct algorithms and architectures, formal verification, reachability analysis, fuzzing, novel test case generation approaches, and/or offline verification techniques such as monitoring and bounding of system behavior. Development of verification evidence should be conducted in concert with hazard analysis approaches that consider software failures and human interaction as well as novel approaches to certification based on structured assurance case arguments are of interest. Verification approaches should complement traditional approaches such as failure modes and effects testing/analysis, Monte Carlo simulation, hardware in the loop simulation, flight test, etc.

Research Classification/ Restrictions: Unclassified

Eligible Research Institutions: All DAGSI