A2.06  Smart, Adaptive Aerospace Vehicles With Intelligence

Lead Center: ARC

Participating Center(s): LaRC

This subtopic emphasizes the roles of aerodynamics, aero thermodynamics, adaptive software, vehicle dynamics in nonlinear flight regimes, and advanced instrumentation in research directed towards the identification, development, and validation of enabling technologies that support the design of future, autonomous aerospace vehicle and platform concepts for aviation safety, and security vehicle systems. Some of the vehicle attributes envisioned by this subtopic include: a) "Smart" vehicle attributes-using advanced sensor technologies, flight vehicle systems are "highly aware" of onboard health and performance parameters, as well as the external flow field and potential threat environments; b) "Adaptive" vehicle attributes-flight avionics systems are reconfigurable, structural elements are self-repairing, flight control surfaces and/or effectors respond to changing flight parameters and/or vehicle system performance degradation; and c) "Intelligent" vehicle attributes-vehicle onboard processing and artificial intelligence technologies, interfaced with advanced vehicle structural component and subcomponent designs and appropriate actuating devices, reacts rapidly and effectively to changing performance demands and/or external flight and security threat environments. Future air vehicles with the above attributes will manage complexity, "know" themselves, continuously tune themselves, adapt to unpredictable conditions, prevent and recover from failures, and provide a safe environment.

For atmospheric vehicles and platforms, both military and civil applications are sought, while for aviation applications, emphasis is placed on configurations that enable the discovery of new aviation safety and security concepts. Concepts and corresponding enabling technologies are sought which expand the traditional boundaries of conventional piloted vehicles categories such as General Aviation (GA) or Personal Air Vehicles (PAV), as well as significantly advance the state-of-the-art in remotely operated vehicle classes such as Long-Endurance Sensing Platforms (LESP), Unmanned Aerial Vehicles (UAV) or Unmanned Combat Aerial Vehicles (UCAV) as they can relate to aviation safety and security. Furthermore, for Earth applications, special emphasis is placed on research proposals that attempt to provide solutions for a future state in which revolutionary vehicles operate in a highly integrated airspace including hub and spoke, point-to-point, long-haul, unmanned aircraft, green aircraft, as well as a future state where air vehicle designs reflect a high level of integration in performance, safety and security, airspace capacity, environmental impact and cost factors.

There are a number of specific areas of interest:

- Conceptual flight vehicle/platform designs featuring variable levels of vehicle and airspace requirements integration, and/or smart, intelligent, and adaptive flight vehicle capabilities, as demonstrated by state-of-the-art systems analyses methods to determine enabling technologies and resulting impacts on future system integrated performance, environmental impact, and safety and security issues;

- New algorithms for predicting vehicle loads and response using minimal vehicle state information;
• Novel optimization methodologies to support conceptual design studies for highly-integrated flight vehicle and air space concepts and/or smart, intelligent and adaptive flight vehicle capabilities, which demonstrate appropriate design variable selection, scaling techniques, suitable cost functions, and improved computational efficiency;

• Physics-based modeling and simulation tools of multiple vehicle classes and corresponding airspace operations aspects to support scenario-based planning and requirements definition of highly integrated vehicle and airspace capacity concepts, including investigations of the potential use of virtual/immersive simulations on future engineering decision making processes; and

• Micro-scale wireless communications, health monitoring, energy harvesting, and power-distribution technologies for large arrays of vehicle-embedded MEMS sensors and actuators.