A2.07 Aircraft Control and Dynamics

Lead Center: GRC

Participating Center(s): AFRC, ARC, LaRC

Enabling advanced aircraft configurations for subsonic, supersonic and hypersonic flight, and high performance "Intelligent Engines" will require advancement in the state of the art of dynamic modeling and flight/propulsion control. Control methods need to be developed and validated for "optimal" and reliable performance of complex, unsteady, and nonlinear systems with significant modeling uncertainties while ensuring operational flexibility, enabling unique concepts of operations, lower emissions and noise, and safe operation over a wide operating envelope. New dynamic modeling and simulation techniques need to be developed to investigate dynamic performance issues and support development of control strategies for innovative aircraft configurations with enhanced control effectors and propulsion systems. Proposals for novel multidisciplinary nonlinear dynamic systems modeling, identification, and simulation for control objectives are encouraged. Control objectives include feasible and realistic boundary layer and laminar flow control, aeroelastic maneuver performance, and load control including smart actuation and active aerostructural concepts, active control of propulsion system components, and drag minimization for high efficiency and range performance. Technology needs specific to different flight regimes are summarized in the following:

For subsonic fixed wing aircraft, technologies of interest, with application to both flight and propulsion control, include: methods for development of dynamic models and simulations of the integrated component/control system being considered; defining actuation requirements for novel control approaches and developing prototype actuators; developing and applying innovative control methods and validating them through laboratory test and vehicle simulations as appropriate.

For supersonic flight, the technologies of interest include: methods for developing integrated dynamic models and simulation including flexibility effects and suitable for control design; novel control design methods for integrated aero-servo-elastic-propulsive control leading to acceptable flying qualities over the operating flight envelope; novel, and feasible, takeoff and approach to landing procedures to accommodate the visibility challenges due to long forebodies; integrated inlet/engine control to ensure safe (no inlet unstart) and efficient operation.

For hypersonic flight, the technologies of interest include: system dynamic models incorporating the essential coupled dynamic elements with varying fidelity for control design, analysis and evaluation; methods for characterizing uncertainty in the dynamic models to enable control robustness evaluation; hierarchical GNC (Guidance, Navigation and Control) architectures to enable trajectory shaping and control over a wide operating envelope with integrated flight/propulsion control; adaptive and robust control methods that can handle large modeling uncertainties; simulation test-beds for evaluating hypersonic concept vehicle control under various types of uncertainty, system-wide coupling and associated model mis-specification.