**4000-Character Abstract**

The proposed research aims to develop technologies to prevent accidents and incidents resulting from aircraft loss of control (LOC) as a significant contribution in the ongoing effort to improve the overall safety of the current and future air transportation system. Our proposed framework implements an Integrated Reconfigurable Controller for Vehicle Resilience (iReCoVeR) that consists of a Resilient Flight Controller, a Flight Envelope Protection system with an LOC Prediction scheme, a Fault Detection and Isolation module, and a Flight Envelope Determination system. With this integrated framework, we address the four subtopics of research topic VSST1-8.

The Resilient Flight Controller is the first line of defense against adverse conditions. The Resilient Flight Controller is a high-performance flight control law designed to provide short-term stabilization of the aircraft as well as improved maneuverability margins at challenging flight conditions or in the event of moderate faults and failures. The Flight Envelope Protection system ensures that the aircraft stays within its safe operational envelope by overriding, limiting, or shaping the commands generated by the pilot or autopilot. Assisted by the LOC Prediction scheme, it also detects proximity to the boundaries of the envelope and determines the ‘best’ strategy to recover a normal operating condition. The Fault Detection and Isolation module is responsible for detecting and isolating adverse conditions such as sensor failures, vehicle impairment, or ice accretion. Lastly, the Flight Envelope Determination module determines an accurate estimate of the current operational envelope of the possibly impaired aircraft.

In the evaluations of the developed technologies a wide range of adverse conditions will be considered. They will include system failures like sensor failures, vehicle impairment (e.g. due to structural damage and icing conditions), and also external disturbances such as turbulence and wake vortices. Integral part of the proposed work is the development of state-of-the-art aircraft icing models to aid in detection and mitigation of aircraft impairment due to ice accretion. Research will be conducted to obtain both symmetric and asymmetric models of icing accretion, and also extensions will be developed to include unsteady aerodynamic effects due to the coupled effects of the rapid movement of the wing and tail control surfaces with icing. Besides modeling of icing accretion, this research effort also includes the development of methods to detect, isolate, estimate, and mitigate sensor failures, that play a major role in aircraft loss-of-control accidents.

The proposed framework will be designed to perform under a combination of multiple adverse conditions and pilot input errors. Therefore, carefully designed human-in-the-loop experiments on full-scale aircraft models will be conducted to evaluate the controller under these challenging conditions. The experiments will be conducted at the human-in-the-loop flight simulation facility at the University of Illinois. The state-of-the-art medium-fidelity flight simulator is highly reconfigurable in both software and hardware. The simulation can be programmed so that specified adverse conditions occur at specified times during flight, and heads-up, heads-down and lateral displays can be added with ease. Part of the validation process is the development of metrics to quantify the nature and magnitude of crew errors leading to an LOC event, as well as the performance during recovery with and without iReCoVeR. Subsequently, the developed iReCoVeR system for LOC prevention will be transitioned to NASA Langley Research Center for implementation on the AirSTAR flight test facility, which provides an actual flight environment to validate the developed technologies.