Integrated Resilient Aircraft Control Project

Full Scale Flight Validation

NESC GN&C Face-to-Face in Chicago
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Full-Scale Flight Test Overview

- **Objective**
  - Provide validation of adaptive control law concepts through full scale flight evaluation.

- **Technical Approach**
  - Engage failure mode – destabilizing or frozen surface.
  - Perform formation flight and air-to-air tracking tasks
  - Evaluate adaptive algorithm
    - Stability metrics
    - Model following metrics
NASA NF-15B #837

- Last flight flown on Jan 30, 2009
  - Indirect adaptive (Gen 1) – 1999
  - Direct adaptive (Gen 2) – 2006
  - Improved direct adaptive (Gen2a/b) – 2008

- Future flights will be on F/A-18 #853
Video from F15 Flight Test

Gen2 & Gen2a Sigma Pi Flight Results

Note: Reduced Tracking errors for similar Pilot Inputs
IRAC F-18 #853 Testbed

- Dedicated Ghz processor for experiment
- Shell & process for Simulink autocode (or c-code)
- Can control commands to:
  - All aero surfaces (except speed brake)
  - All pilot inputs
  - Both engine throttles independently
- Limit checks done by Class A software in RFCS
- Potential for Class A experiment (dual ARTS IV or in quad RFCS) – take to landing?
- Tons of research instrumentation parameters
- Simulated failure of multiple control surfaces

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Experiment Peer Review Process

- Brainstorming within NASA
- Release an RFI for feedback and other ideas from Industry / Academia
- Workshop with Industry / Academia – possibly St. Louis at ACC time
- Final selection by NASA
- Flights in 2011
- Continue process for next experiments

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RFI Objectives

- Objective 1: To validate adaptive control technology using manned flight experiments
  - Experiments addressing:
    - Challenges that can only be addressed by manned flight
    - Address barriers to implementation
    - Sufficiently large (or meaningful) failures

- Objective 2: To examine the benefits of manned Vs autonomous recovery
  - Experiments addressing:
    - Types of pilot input to system
    - Separate, backup, or primary flight control implementation
    - Interactive adaptive
RFI Objectives

- Objective 3: To test and validate system-level reasoning for flight control reconfiguration
  - Experiments addressing:
    - Detection, diagnosis, prognosis, and isolation technologies for control reconfiguration and envelope limiting controls
Conclusions

• Full scale flight testing provides an ability to validate different adaptive flight control approaches

• Full scale flight testing adds credence to NASA’s research efforts

• A sustained research effort is required remove the road blocks and provide adaptive control as a viable design solution for increase aircraft resilience.